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THIRTY-FIFTH ANNUAL REPORT

of

Forage Research

in the

Northeastern United States

1971

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1971
Thirty-Fifth Annual Report
of
Forage Research
in the
Northeastern United States

A Joint Contribution of the
U.S. Regional Pasture Research Laboratory
and the
Agricultural Experiment Stations
of the
Twelve Northeastern States

Contributing Agencies

Forage and Range Research Branch, Plant Science Research Division
Northeast Branch, Soil and Water Conservation Research Division
Grain and Forage Insects Research Branch, Entomology Research Division
of the
Agricultural Research Service, U.S. Department of Agriculture

and the

Agricultural Experiment Stations of

| | |
|---------------|---------------|
| Connecticut | New Jersey |
| Delaware | New York |
| Maine | Pennsylvania |
| Maryland | Rhode Island |
| Massachusetts | Vermont |
| New Hampshire | West Virginia |

* * * * *
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 * Pennsylvania 16802.
 * * * * *

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TO THE COLLABORATORS:

| | | |
|---|----------------------|-----------------|
| D. W. Allinson - Connecticut | W. R. Battle | - New Jersey |
| W. H. Mitchell - Delaware | C. C. Lowe | - New York |
| C. S. Brown - Maine | J. L. Starling | - Pennsylvania |
| N. A. Clark - Maryland | B. W. Henderson, Jr. | - Rhode Island |
| H. Fenner - Massachusetts | G. M. Wood | - Vermont |
| G. L. Byers - New Hampshire | R. L. Reid | - West Virginia |
| W. I. Thomas - Representative of Northeastern Directors | | |

This Annual Report is intended primarily for use by forage research workers in the Northeastern United States. It contains brief reports of research projects carried on at most of the State Agricultural Experiment Stations in the region. It also includes reports from several Regional Research Technical Committees, the U.S. Regional Pasture Research Laboratory, and from research personnel of the Agricultural Research Service, U.S. Department of Agriculture at Beltsville, Maryland. Our appreciation is extended to all contributors and to the Collaborator at each station who coordinated the collection of reports.

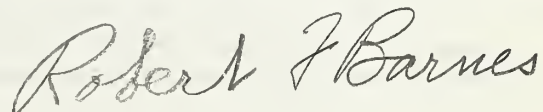
The only change in Collaborators during 1971 was the appointment of Dr. J. L. Starling in place of Dr. R. W. Cleveland at Pennsylvania. Three new members joined the Laboratory staff during 1971. These included:

DAVID L. GUSTINE -- Plant Physiologist, Plant Science Research Division, ARS, USDA; B.A., 1964, Malone College; Ph.D., 1969, Michigan State University. Research Areas: Metabolic constituents in plants influencing forage quality; biochemical basis for plant resistance to diseases and insects; regulation of protein synthesis during tissue differentiation.

ROBERT T. SHERWOOD -- Research Plant Pathologist, Plant Science Research Division, ARS, USDA; adjunct professor of Plant Pathology, The Pennsylvania State University; B.S., 1952 and M.S., 1954, Cornell University; Ph.D., 1958, The University of Wisconsin. Research Areas: Pathology of forage crops; effect of pathogens on plant biochemical constituents; nature of plant resistance to diseases.

DOROTHY J. SIMPSON (Mrs.) -- Clerk Typist.

In my travels throughout the Northeast, I was continually impressed with the concern of individuals to develop a relevant program of research in cooperation with scientists in other disciplines within their own stations as well as in other states. It is my hope that the Laboratory can serve in a positive way to stimulate and coordinate interdisciplinary research in forages and grasslands during the next few years. This will be realized only to the extent that administrators and scientists in all research agencies work and plan together to meet the research needs of the future.



Director, U.S. Regional
Pasture Research Laboratory

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Roster of Research Workers in the
Northeastern United States

| <u>Name</u> | <u>Field of Research</u> | <u>Department</u> |
|----------------------------------|--------------------------|---|
| <u>University of Connecticut</u> | | |
| Storrs 06268 | | |
| Allinson, D. W.* | Forage Management | Plant Science |
| Cowan, W. A. | Animal Nutrition | Animal Industries |
| Dest, W. M. | Weed Investigations | Plant Science |
| Fellows, I. F. | Agricultural Economics | Agricultural Economics |
| Griffin, G. F. | Soil Fertility | Plant Science |
| Peters, R. A. | Weed Investigations | Plant Science |
| Prince, R. P. | Agricultural Engineering | Agricultural Engineering |
| Pudelkiewicz, W. J. | Animal Nutrition | Nutritional Sciences |
| Washko, W. W. | Forage Management | Plant Science |
| Wengel, R. W. | Soil Physics | Plant Science |
| <u>University of Delaware</u> | | |
| Newark 19711 | | |
| Connell, W. A. | Insect and Mite Control | Entomology and Applied Ecology |
| Crittenden, H. W. | Legume Diseases | Plant Science |
| Fowler, R. E. | Beef Cattle Nutrition | Animal Science and Agri- cultural Biochemistry |
| Haenlein, G. F. W. | Nutritive Evaluation | do. |
| Jones, E. R. | Forage Management | Dept. of Agriculture Delaware State College Dover, Del. 19901 |
| Mitchell, W. H.* | Forage Management | Plant Science |
| Reitnour, C. M. | Horse Physiology | Animal Science and Agri- cultural Biochemistry |
| Svec, L. V. | Physiology | Plant Science |
| <u>University of Maine</u> | | |
| Orono 04473 | | |
| Apgar, W. P. | Forage Utilization | Animal and Veterinary Sci. |
| Brown, C. S.* | Forage Management | Plant and Soil Sciences |
| Dickey, H. C. | Forage Preservation | Animal and Veterinary Sci. |
| Holyoke, V. H. | Silage Corn Management | Plant and Soil Sciences |
| Rowe, R. J. | Engineering Harvesting | Agricultural Engineering |
| Simpson, G. W. | Forage Insects | Entomology |

| <u>Name</u> | <u>Field of Research</u> | <u>Department</u> |
|------------------------------------|------------------------------------|---|
| <u>University of Maryland</u> | | |
| College Park 20742 | | |
| Bezdicek, D. F. | Forage Management | Agronomy |
| Bickley, W. E. | Entomology | Entomology |
| Burt, G. W. | Weed Control | Agronomy |
| Clark, N. A.* | Forage Management | Agronomy |
| Decker, A. M., Jr. | Forage Management | Agronomy |
| Harris, W. L. | Agricultural Engineering | Agricultural Engineering |
| Hofmann, L. | Forage Management | Agronomy |
| Leffel, E. C. | Animal Science | Animal Science |
| Morgan, O. D., Jr. | Plant Pathology | Botany |
| Parochetti, J. V. | Weed Control | Agronomy |
| Schillinger, J. A. | Plant Breeding | Agronomy |
| Steinhauer, A. L. | Entomology | Entomology |
| Vandersall, J. H. | Dairy Science | Dairy Science |
| <u>University of Massachusetts</u> | | |
| Amherst 01002 | | |
| Colby, W. G. | Forage Management | Plant and Soil Sciences |
| Drake, Mack | Forage Management | Plant and Soil Sciences |
| Fenner, Heinrich* | Animal Nutrition | Veterinary and Animal Sci. |
| Jensen, G. L. | Entomology | Entomology |
| Vengris, Jonas | Weed Control | Plant and Soil Sciences |
| Weeks, Martin E. | Forage Management | Plant and Soil Sciences |
| Whitney, L. E. | Agricultural Engineering | Agricultural Engineering |
| <u>University of New Hampshire</u> | | |
| Durham 03824 | | |
| Byers, G. L.* | Agricultural Engineering | Institute of Natural and Environmental Resources |
| Dunn, G. M. | Genetics | Plant Science |
| Estes, G. O. | Forage Nutrition | Plant Science |
| Holter, J. B. | Animal Nutrition | Animal Sciences |
| Koch, D. W. | Forage Plant Physiology | Plant Science |
| Mitchell, J. R. | Forage Management | Plant Science |
| O'Connor, J. T. | Animal Science | Animal Sciences |
| Peirce, L. C. | Genetics and Horticulture Crops | Plant Science |
| Routley, D. G. | Plant Chemistry | Plant Science |

| <u>Name</u> | <u>Field of Research</u> | <u>Department</u> |
|--|----------------------------|------------------------------------|
| Rutgers University, The State University of New Jersey New Brunswick 08903 | | |
| Alderfer, R. B. | Soil-Plant-Water Relations | Soils and Crops |
| Battle, W. R.* | Environmental Research | Soils and Crops |
| Duehl, R. W. | Highway Vegetation | Soils and Crops |
| Evans, J. L. | Nutritional Value | Animal Science |
| Flannery, R. L. | Soil Fertility | Soils and Crops |
| Halisky, P. M. | Plant Pathology | Plant Biology |
| Ilnicki, R. D. | Weed Control | Soils and Crops |
| Mears, D. R. | Agricultural Engineering | Engineering |
| Race, S. R., Jr. | Forage Insects | Entomology and Economic Zoology |
| Ramage, C. H. | Production Utilization | Animal Science |
| Singley, M. E. | Engineering, Utilization | Engineering |
| Sprague, M. A. | Management, Preservation | Soils and Crops |
| Vander Noot, G. W. | Forage Utilization | Animal Science |

Cornell University (New York)
Ithaca 14850

| | | |
|------------------|-------------------------------------|--------------------------------|
| Campbell, J. K. | Agricultural Engineering | Agricultural Engineering |
| Duke, W. B. | Weed Control | Agronomy |
| Fick, G. W. | Forage Physiology and Management | Agronomy |
| Gyrisco, G. G. | Entomology | Entomology |
| Linscott, D. L. | Weed Control | Agronomy |
| Lowe, C. C.* | Genetics and Breeding | Plant Breeding and Biometry |
| Lucey, R. F. | Forage Management | Agronomy |
| Millar, R. L. | Plant Pathology | Plant Pathology |
| Millier, W. F. | Agricultural Engineering | Agricultural Engineering |
| Murphy, R. P. | Genetics and Breeding | Plant Breeding and Biometry |
| Pardee, W. D. | Forage Management | do. |
| Reid, J. T. | Animal Nutrition | Animal Science |
| Schaaf, H. M. | Genetics and Breeding | Plant Breeding and Biometry |
| Seaney, R. R. | Forage Management | Agronomy |
| Van Soest, P. J. | Animal Nutrition | Animal Science |
| Wright, M. J. | Forage Management | Agronomy |

| <u>Name</u> | <u>Field of Research</u> | <u>Department</u> |
|---|---|---|
| <u>New York State Agricultural Experiment Station</u> Geneva 14456 | | |
| Braverman, S. W. | Plant Pathology | Seed Investigations and PSR, ARS, USDA |
| Dolan, D. D. | Plant Introduction | do. |
| Nittler, L. W. | Seed Research | Seed Investigations |
| <u>The Pennsylvania State University</u> University Park 16802 | | |
| Ace, D. L. | Dairy Extension | Dairy Science |
| Adams, R. S. | Dairy Extension | Dairy Science |
| Barr, W. L. | Farm Management | Agricultural Economics and Rural Sociology |
| Baumgardt, B. R. | Animal Nutrition | Animal Science |
| Baylor, J. E. | Pasture and Forage Crops (Extension) | Agronomy Extension |
| Bloom, J. R. | Nematode Control | Plant Pathology |
| Burdette, L. A. | Animal Nutrition Ext. | Animal Science |
| Cleveland, R. W. | Genetics and Breeding | Agronomy |
| Cowan, R. L. | Animal Nutrition | Animal Science |
| Downs, W. G. | Forage Management | Agronomy (P.O. Rector) |
| Dum, S. A. | Farm Management Ext. | Economics |
| Guss, S. B. | Veterinary Sci. Ext. | Veterinary Science |
| Hershberger, T. V. | Animal Nutrition | Animal Science |
| Hower, A. A., Jr. | Forage Insects | Entomology |
| Johnson, M. W. | Corn Breeding | Agronomy |
| Kardos, L. T. | Soil Physics | Agronomy |
| Kesler, E. M. | Dairy Science | Dairy Science |
| Kjelgaard, W. L. | Agricultural Engineering | Agricultural Engineering |
| Kradel, D. C. | Veterinary Medicine | Veterinary Science |
| Long, T. A. | Animal Nutrition | Animal Science |
| Lukezic, F. L. | Forage Pathology | Plant Pathology |
| Marriott, L. F. | Soil Fertility | Agronomy |
| Matelski, R. P. | Land Classification | Agronomy |
| McKee, G. W. | Ecology, Physiology | Agronomy |
| Merritt, T. L. | Animal Science | Animal Science |
| Partenheimer, E. J. | Agricultural Economics | Agricultural Economics and Rural Sociology |
| Risius, M. L. | Genetics and Breeding | Agronomy |
| Shenk, J. S. | Forage Grass Breeding | Agronomy |
| Starling, J. L.* | Genetics and Breeding | Agronomy |
| Thomas, W. I. | Representative NE Directors | Agricultural Experi- ment Station |
| Washko, J. B. | Forage Management | Agronomy |
| Wilson, L. L. | Animal Science | Animal Science |
| Yendol, W. G. | Non-Pesticide Insect Control | Entomology |

| <u>Name</u> | <u>Field of Research</u> | <u>Department</u> |
|-----------------------------------|--------------------------|--|
| <u>University of Rhode Island</u> | | |
| Kingston 02881 | | |
| Henderson, B. W., Jr.* | Animal Nutrition | Animal Science |
| Wakefield, R. C. | Forage Management | Plant and Soil |
| <u>University of Vermont</u> | | |
| Burlington 05401 | | |
| Bartlett, R. J. | Soil Science | Plant and Soil Science |
| Benoit, G. R. | Soil Physics | do. |
| Bornstein, J. | Agricultural Engineering | Agricultural Engineering |
| Flanagan, T. R. | Weed Control | Plant and Soil Science |
| MacCollom, G. B. | Entomology | Entomology |
| McIntosh, J. L. | Soil Science | Plant and Soil Science |
| Parker, B. L. | Entomology | Entomology |
| Schneider, E. C. | Agricultural Engineering | Agricultural Engineering |
| Smith, A. M. | Animal Nutrition | Animal Sciences |
| Sproston, T. | Plant Pathology | Botany |
| Varney, K. E. | Forage Management | Plant and Soil Science |
| Welch, J. G. | Nutritional Value | Animal Sciences |
| Wiggans, S. C. | Plant Pathology | Plant and Soil Science |
| Wood, G. M.* | Forage and Turf Mgmt. | Plant and Soil Science |
| <u>West Virginia University</u> | | |
| Morgantown 26506 | | |
| Anderson, G. C. | Animal Nutrition | Animal and Veterinary Sciences |
| Baker, B. S. | Forage Management | Allegheny Highlands Project, Elkins, W.Va. |
| Balasko, J. A. | Forage Physiology | Plant Sciences |
| Bennett, O. L. | Forage Management | Plant Sciences and SWC, ARS, USDA |
| Butler, Linda | Entomology | Plant Sciences |
| Diener, R. G. | Agricultural Engineering | Resource Management |
| Elliott, E. S. | Root Diseases | Plant Sciences |
| Horvath, D. J. | Animal Nutrition | Animal and Veterinary Sciences |
| Keefer, R. F. | Soil Fertility | Plant Sciences |
| Maxwell, R. H. | Agricultural Education | Allegheny Highlands Project, Elkins, W.Va. |
| Pohlman, G. G. | Soil Fertility | Plant Sciences (Emeritus) |
| Reid, R. L.* | Animal Nutrition | Animal and Veterinary Sciences |
| Thomas, R. O. | Dairy Nutrition | do. |
| Toben, G. E. | Agricultural Economics | Resource Management |
| Ulrich, Valentin | Plant Breeding | Plant Sciences |
| Veatch, Collins | Weed Control | Plant Sciences (Emeritus) |

| <u>Name</u> | <u>Field of Research</u> | <u>Department</u> |
|--------------------------------------|-----------------------------------|--------------------------|
| U.S. Department of Agriculture | | |
| <u>Agricultural Research Service</u> | | |
| Beltsville, Maryland 20705 | | |
| Barrows, H. L. | Branch Chief | Northeast Branch, SWC |
| Carlson, G. E. | Plant Physiology | Forage and Range |
| | | Research Branch, PSR |
| Carter, M. C. | Assistant Branch Chief | Northeast Branch, SWC |
| Chatterton, N. J. | Biochemistry | Forage and Range |
| | | Research Branch, PSR |
| Dahms, R. G. | Branch Chief | Grain and Forage Insects |
| | | Research Branch, ENT |
| Devine, T. E. | Alfalfa Breeding | Forage and Range |
| | | Research Branch, PSR |
| Elden, T. C. | Forage Insects | Grain and Forage Insects |
| | | Research Branch, ENT |
| Garrison, C. S. | Seed Production | Forage and Range |
| | | Research Branch, PSR |
| Hanson, A. A. | Branch Chief | do. |
| Hanson, C. H. | Alfalfa Breeding and Genetics | do. |
| Hart, R. H. | Pasture Production and Management | do. |
| Juska, F. V. | Grass and Turf Management | do. |
| Leffel, R. C. | Clover Investigations | do. |
| Luginbill, P., Jr. | Assistant Branch Chief | Grain and Forage Insects |
| | | Research Branch, ENT |
| Neal, J. W., Jr. | Forage Insects | do. |
| Ostazeski, S. A. | Plant Pathology | Forage and Range |
| | | Research Branch, PSR |
| Powell, J. B. | Grass and Turf Investigations | do. |
| Ratcliffe, R. H. | Forage Insects | Grain and Forage Insects |
| | | Research Branch, ENT |
| Schroder, R. F. W. | Forage Insects | do. |
| Wilton, A. C. | Grass Genetics and Breeding | Forage and Range |
| | | Research Branch, PSR |

| <u>Name</u> | <u>Field of Research</u> | <u>Department</u> |
|--|--------------------------|--|
| <u>U.S. Regional Pasture Research Lab.</u> | | |
| U.S. Department of Agriculture | | |
| Agricultural Research Service | | |
| University Park, Pa. 16802 | | |
| Barnes, R. F. | Forage Evaluation | Forage and Range Research Branch, PSR |
| Berg, C. C. | Genetics (Grasses) | do. |
| Byers, R. A. | Forage Insects | Grain and Forage Insects Research Branch, ENT |
| Fissel, G. W. | Chemist | Forage and Range Research Branch, PSR |
| Gross, C. F. | Soil Fertility | Northeast Branch, SWC |
| Gustine, D. L. | Biochemistry | Forage and Range Research Branch, PSR |
| Hill, R. R., Jr. | Genetics (Alfalfa) | do. |
| Jung, G. A. | Forage Management | Northeast Branch, SWC |
| Kendall, W. A. | Plant Physiology | Forage and Range Research Branch, PSR |
| Leath, K. T. | Pathology (Legumes) | do. |
| Sherwood, R. T. | Pathology (Grasses) | do. |
| Zeiders, K. E. | Plant Pathology | do. |

* Collaborator to the U.S. Regional Pasture Research Laboratory

RESEARCH IN THE NORTHEASTERN REGION

Section I

Breeding, Genetics, and Plant Introduction Research

Title: REPORT OF REGIONAL PLANT INTRODUCTION, GENEVA, AND REGIONAL PROJECT NE-9 - THE INTRODUCTION, TESTING, MULTIPLICATION AND PRESERVATION OF POTENTIALLY VALUABLE PLANTS FOR CROP IMPROVEMENT AND INDUSTRIAL USE

Leaders: D. D. Dolan, Coordinator and O. M. Rogers, Chairman, Regional Technical Committee; S. W. Braverman and W. R. Sherring

Cooperators: Fourteen State Agricultural Experiment Stations of the 12 Northeastern States, the New Crops Research Branch, ARS; the Cooperative State Research Service, the Soil Conservation Service, and the Forest Service, USDA

The program of the Regional Plant Introduction Station is directed to growing, evaluating, seed increasing and seed distributing introductions of forage legumes and forage grass crops.

During 1971 more than 975 forage legume and grass introductions were grown and described and will be so noted in the biennial catalog of Available Forage Legume and Grass Introductions, released in February 1972. Also, 5000 seed packets were distributed to approximately 200 plant breeders and cooperators during 1971.

In October 1971 a publication entitled "Plant Germplasm for the Northeast," Northeast Regional Publication, Geneva Special Report No. 6 was released to plant breeders, agronomists, and plant pathologists. This report describes in part, promising forage legume and grass introductions that were under observation at some time during 1953-1965. Copies of this report are available from the Regional Plant Introduction Station, Geneva for distribution to interested persons.

An extensive publication entitled "The National Program for Conservation of Crop Germplasm" (a progress report on federal/state cooperation) was released in June 1971. This is a joint publication involving personnel at the four Regional Plant Introduction Stations, the New Crops Research Branch, the Cooperative State Research Service, and the Inter-Regional

Potato Project and was edited by Mr. Sam Burgess of the Georgia Agricultural Experiment Station and subsequently published by the University Printing Department, University of Georgia, Athens. Examples of forage legumes and grass introductions described in this report are drawn largely from information provided to the coordinators of the respective regional projects and the New Crops Research Branch by scientists in state and federal agencies, industry, and private institutions. Much of the disease screening work and agronomic evaluations of the crops have been accomplished at the Regional Plant Introduction Stations. Copies of this report are also available at the Regional Plant Introduction Station, Geneva.

Notes on the promising introductions of 1970 and 1971 were combined with cooperators' evaluations and released as "Promising Introductions of 1970" (Supplement II to the Annual Report, NE-9, 1971). The following are some of the most promising introductions reported during 1971:

PI 259530 - Alfalfa (Medicago sativa). Early spring growth equal to and fall growth superior to 'Rambler.'

PI 268065 - Alfalfa. Early spring growth better than Rambler, fall growth very good.

White clover accessions PI 282380-381, 282374, 282377, 283279, 239981-982, 241460, 243571, 250790, 120107, 195531, 195533, 208730, and 239976 appear tolerant to root knot nematode.

PI 290375 - Birdsfoot trefoil (Lotus corniculatus). Produces abundant leaves, good recovery after cutting.

PI 187101, 303820, 303823, 303819, and 315082 - Birdsfoot trefoil. All show very little winter injury.

A tall oatgrass (PI 255466). Resistant to ergot.

Two brome-grasses (PI 234715 Bromus erectus and 227661 B. sterilis). Resistant to ergot.

An annual ryegrass (PI 241919). Resistant to ergot.

A meadow fescue (PI 184041). Resistant to ergot.

A tall fescue (PI 235036). Which is very vigorous, very leafy and possesses excellent winterhardiness and spring recovery.

A timothy (Phleum pratensis). Which is very vigorous, late maturing and possesses excellent winterhardiness and spring vigor.

Title: REGIONAL PROJECT NE-74 - BREEDING OF IMPROVED VARIETIES OF FORAGE SPECIES ADAPTED TO THE NORTHEAST

Leader: G. M. Dunn, Chairman, Regional Technical Committee

Contributors: The Connecticut, Maryland, New Hampshire, New York, and Pennsylvania Agricultural Experiment Stations; the U.S. Regional Pasture Research Laboratory and Forage and Range Research Branch, ARS, the Cooperative State Research Service, USDA; and the American Seed Trade Association

Major emphasis was given to methods of strain synthesis and evaluation of synthetic generations of alfalfa, brome grass, birdsfoot trefoil, orchardgrass, and timothy. Genetic studies were conducted with alfalfa and brome grass and initiated on crownvetch; cooperative seed production and evaluation of new varieties were continued.

Studies on strain synthesis: Alfalfa. Syn 1 seeds were produced for 100 experimental synthetics, with 1 to 16 parental clones per synthetic (Pasture Lab). Selection for anthracnose resistance significantly increased plant survival and yield (Md.)

Orchardgrass. Data were obtained on forage yield and quality for six late synthetics. Yields did not differ significantly, but 1 synthetic had superior quality as measured by in vitro techniques (Pa.)

Brome grass. The superiority of syn 1 over syn 2 in brome grass synthetics was more pronounced in the first than in the second harvest year (approximately 0.7 tons/ha in 1970 vs. 0.2 tons/ha in 1971) (N.H.)

Genetic studies: Alfalfa. Nature of gene action is being determined by evaluation of parental clones and their S₁ and S₃ generations. Genotypes responded differently to inbreeding (Pasture Lab). Resistance to anthracnose was inherited tetrasomically as a single dominant gene (Md.)

Brome grass. Three ploidy levels, 4N, 6N and 8N Bromus inermis were evaluated for stomatal length, stomatal frequency and pollen grain diameter. Stomatal length is an excellent index for screening for polyploid plants (N.H.)

Seed production: Experimental synthetics were produced in alfalfa, birdsfoot trefoil, brome grass, orchardgrass, and timothy in several states. Artificial air movement greatly improved seed set in muslin cages for Lolium-Festuca hybrid derivatives (Pasture Lab).

Evaluation of new synthetics: Synthetic and cultivar trials were conducted with all of the above species. These trials provide

essential information for the synthesis of improved strains and for varietal recommendations.

Title: REGIONAL PROJECT NE-75 -- BREEDING FOR IMPROVED FORAGE QUALITY

Leader: R. F. Barnes, Chairman, Regional Technical Committee

Contributors: The Maryland, Minnesota, New York, Pennsylvania and Wisconsin Agricultural Experiment Stations; the U.S. Regional Pasture Research Laboratory and Forage and Range Research Branch, ARS, the Cooperative State Research Service, USDA

Studies to determine the genetic variability for agronomic and quality traits have been initiated for alfalfa (NY, Md., USRPRL), smooth brome grass (Wis.), crownvetch (Pa.), orchardgrass (Pa., Wis., USRPRL), reed canarygrass (Minn.), ryegrass-fescue (Lolium-Festuca) hybrid derivatives (USRPRL), and timothy (NY, USRPRL).

Total protein production per plant and % N were increased in alfalfa through two cycles of selection for tolerance to sub-herbicide levels of simazine and increased percentage of protein (Md.).

Diallel crosses and parent clones from three cultivars of alfalfa have been established to study the genetic variability of forage quality using laboratory methods (USRPRL).

Forage produced in growth chambers from parent clones for six alfalfa synthetics differing in expression of leafiness and the multifoliolate characteristic will be analyzed for in vitro dry matter disappearance (IVDMD) to determine its potential as a selection criterion.

Alfalfa cultivars and synthetics are being tested for variation in IVDMD and other quality components (NY, Pa.) Studies have been initiated to determine the nonstructural carbohydrate concentration among 9 forage species and cultivars within species (USRPRL). Preliminary data indicate high carbohydrate levels in timothy, smooth brome grass, reed canarygrass, tall fescue and perennial ryegrass at the vegetative growth stage. Carbohydrate levels decreased differentially among species with advancing growth stage and nitrogen fertilizer.

Crownvetch, sainfoin, birdsfoot trefoil, and alfalfa forages were fed to voles (Microtus pennsylvanicus). Vole intake of diets containing crownvetch was very low compared to the other legumes.

Cultivars of 'Chemung,' 'Emerald,' and 'Penngift' had resulted in low weight gains or death when fed to weanling meadow voles. However, vole performance when fed forage from individual Chemung plants indicated that variability may exist among plants for the deleterious substance contained in the forage (Pa. and USRPRL).

A field study of vegetatively propagated Lolium-Festuca hybrid derivative clones, originally selected for a range in lignin content, and the polycross progeny of these clones has been initiated. The determination of structural constituents and IVDMD is underway on three harvests made during 1971 (USRPRL).

In a regional study involving Minnesota and Indiana, the highly significant correlation between total alkaloid concentration and palatability for September harvests of reed canarygrass was $r = 0.95$ ($n = 18$).

Type of alkaloid was not related to the palatability characteristics of a given genotype. The accumulated alkaloid concentrations for the August and September harvests for 116 clones indicate a frequency distribution skewed to the lower end of the scale (Minn.)

Research is being conducted to answer some of the problems inherent with harvesting, sampling, and processing of forage material (NY, Pa.) Alfalfa and orchardgrass forage samples harvested by hand were higher in IVDMD than those harvested with a flail chopper (Pa.) The flail chopped forage dried at a slower rate than the hand harvested samples, which may have resulted in the differences observed.

Title: ALFALFA, GENETIC VARIABILITY FOR REACTION TO FOLIAR PATHOGENS
IN

Leaders: R. R. Hill, Jr., K. T. Leath, and K. E. Zeiders, Pasture
Research Laboratory

Plants randomly sampled from 'Saranac,' 'MSA-C4,' and 'MSB-C4' alfalfa were used to construct a series of diallel crosses within each cultivar. Reactions of the crosses and parents to Stemphylium botryosum, Pseudopeziza medicaginis, Leptosphaerulina briosiana, Uromyces striatus, and Phoma herbarum (Ascochyta imperfecta) were observed. Estimates of autotetraploid components of genetic variance were obtained from a statistical analysis of the data. Significant additive genetic variance was detected for reaction to U. striatus and P. medicaginis in each of the cultivars, and for reaction to S. botryosum and L. briosiana in MSA-C4 and MSB-C4. Additive genetic variance for reaction to P. herbarum was not detected in any of the cultivars. Nonadditive genetic variance was significant for reaction to U. striatus and P. herbarum in

MSA-C4 and MSB-C4. In general, genetic variances were greater in MSA-C4 and MSB-C4 than in Saranac.

Title: ALFALFA, INBREEDING IN

Leader: R. R. Hill, Jr., Pasture Research Laboratory

This study has been described in previous Reports of Forage Research in the Northeast (see p. 15, 1970 report). Diallel crosses between clones and their S_2 and S_4 progenies were established in row plots in the field on July 15. Two 5-clone diallel crosses in each of two germplasm pools were attempted for each of the parental generations, but poor seed set on some of the inbred lines resulted in some missing entries. Establishment survival to date has been good on all crosses. Data were not collected on the crosses during 1971.

Single clone derived progenies from three families in each of two germplasm pools were evaluated during the summer of 1971. Generations in each family, with slight variations due to differences in seed production, were clone, S_1 , Syn-1- S_1 , S_2 , Syn-1- S_2 , and Syn-1- S_3 . Spring growth height, plant height at each of three harvest times (yields were not determined), recovery height after the first cutting, and fall growth were observed. Preliminary analysis of the data indicates that the genotype of the parent clones had significant effects on the response to inbreeding.

Title: ALFALFA, RELATIVE EFFECTIVENESS OF METHODS OF SELECTION FOR FOLIAR DISEASE RESISTANCE IN

Leaders: R. R. Hill, Jr., K. T. Leath, Pasture Research Laboratory; and W. L. Haag, Pennsylvania

Individual, S_1 and polycross (Px) progeny test, and S_1 and polycross family selection are being compared for effectiveness in selection for resistance to Uromyces striatus, Stemphylium botryosum, and Phoma herbarum in Saranac-An4 alfalfa (obtained from C. H. Hanson, Beltsville, Md.) Eight plants from 144 S_1 families, 144 polycross families, and 137 of the parent clones were evaluated for reaction to each of the pathogens in inoculation chamber facilities during the spring of 1971. The following selections were made for reaction to each of the pathogens: The best 6 parents, best 48 parents, and best 6 families on the basis of polycross progeny performance; the best 6 parents, best 48 parents, and best 6 families on the basis of S_1 progeny performance;

and the best 48 individuals in a bulk inoculation trial. Selected groups were intermated separately, and will be evaluated to compare effectiveness of selection. Only a preliminary analysis of the parent-generation data has been conducted at this time. However, correlations between progeny types were as follows:

| <u>Species</u> | <u>S₁ vs. Px</u> | <u>S₁ vs. clone</u> | <u>Px vs. clone</u> |
|---------------------|-----------------------------|--------------------------------|---------------------|
| <u>P. herbarum</u> | .23** | .24** | -.01 |
| <u>U. striatus</u> | .30** | .38** | .19* |
| <u>S. botryosum</u> | .13 | .15 | .07 |

* and ** indicate correlation greater than zero at .05 and .01 probability levels, respectively.

Except for the P. herbarum score, correlations involving S₁ progeny means (S₁ vs. Px and S₁ vs. clone) were approximately twice the value of the Px vs. clone correlations.

A separate experiment has been initiated to compare the long term effects of individual, polycross (half-sib) family, and full-sib family selection for resistance to P. herbarum and Leposphaerulina briosiana in the experimental alfalfa populations of MSA-CW3An3 and MSB-CW5An3.

Title: ALFALFA AND BIRDSFOOT TREFOIL, BREEDING AND CYTOGENETIC INVESTIGATIONS OF

Leaders: R. P. Murphy and C. C. Lowe, Cornell

Breeding programs on alfalfa are in progress with emphasis on yield, resistance to alfalfa weevil, potato leafhopper and a new insect pest which has been causing damage in the Hudson valley area of New York, alfalfa leaf miner. Promising lines for resistance to the first two pests have been selected for testing.

A series of alfalfa synthetics has been evaluated in preliminary trials. Several of these trace to "exotic" germplasm from Plant Introduction collections. Three or four of these synthetics are being increased for widescale evaluation in the Northeast. Preliminary tests suggest a small increase in yield potential above Saranac.

Northeast trials with birdsfoot trefoil synthetics have not indicated improved yield potential for a number of synthetics derived from a series of released superior clones. These are primarily 4-clone synthetics and present results suggest this may be a too limited genetic base to give improved yield over the currently used wide base cultivars.

Title: ALFALFA AND RED CLOVER, BREEDING AND CYTOLOGY OF

Leaders: R. W. Cleveland, J. L. Starling, and M. L. Risius,
Pennsylvania

Selection of alfalfa lines for resistance to anthracnose diseases was continued. Lines bred from putative disease resistant plants of 'Saranac,' 'Iroquois,' and 'Team' cultivars and other alfalfa sources were inoculated with Colletotrichum trifolii and C. destructivum in separate trials. Selected plants from the Colletotrichum inoculations were treated with Corynebacterium insidiosum to evaluate resistance to bacterial wilt disease. Plants surviving the wilt test will be intercrossed in 1972 to produce another generation for selection. The alfalfa lines under development show reasonably good promise for incorporation into improved varieties.

Populations of creeping rooted alfalfa were advanced in generation. Field experiments were established for the evaluation of progenies which were produced from plants selected for early creeping, upright stems, and vigorous growth. Creeping alfalfa may have use as a long-lived hay or pasture legume.

Experiments to evaluate the field performance of alfalfa and red clover cultivars were established, and data were collected from several older experimental plantings in southeastern and central Pennsylvania. Accumulated information from these trials was used to recommend cultivars for farm use. Eight new older cultivars, most commercially developed, are listed in 1972 recommendations for Pennsylvania.

Title: CROWN VETCH, BREEDING FOR FORAGE AND SOIL STABILIZATION IN

Leaders: M. L. Risius, J. S. Shenk, and R. W. Cleveland, Pennsylvania

Genetic studies of flower color and chlorophyll mutants are being continued. Problems with self-incompatibility and incompatibility between related plants have impeded progress in producing the necessary crosses and the number of plants needed to define inheritance patterns.

Agronomic evaluation of the crownvetch cultivars, 'Penngift,' 'Chemung,' and 'Emerald,' is being continued. Under a two-harvest management system, the forage yield of these cultivars has been about the same, but under a three-harvest management system, forage yield of Chemung and Emerald has been higher than that of Penngift.

Title: POA PRATENSIS, CYTOGENETIC STUDIES IN

Leaders: A. C. Wilton, J. J. Murray, ARS, USDA, Beltsville, Md.

Poa pratensis cultivars were examined for chromosome number. Among twin plants the following numbers were found: Park 49, 72, and 82; Newport 70; Belturf 49, 76; Fylking 70, 112; Cougar 49, 70, and 94; Troy 50, 76; Nugget 90; Baron 80, 114; Windsor 49 and 74. In either single plants or sod the following numbers were found: Park 49, 60; Newport 74, 77; Belturf 49; Fylking 70; Troy 50, 75, 90, 108; Nugget 90; Merion 49, 56; Windsor (sod only) 49, 70; Pennstar 84; Baron 80-83; 117-27 (6) 90.

A complete chromosomal analysis was conducted on the Windsor cultivar to measure genetic and chromosomal change over many years. Windsor plants, grown from seed that was produced 13 and 16 years after selection of its ancestral clone, were cytologically analyzed. Since it was believed possible that a red pigment, observed in seedlings of this and other cultivars, was related to chromosome numbers, pigmented and non-pigmented seedlings from large and small Windsor seeds were grown in a growth chamber and pigment intensities and chromosome numbers determined.

Pigmentation, seed size, and chromosome number proved to be related in most of these seedlings. Large seeds produced 93% pigmented seedlings; small seeds, 86% nonpigmented seedlings. Eighty-four percent of the pigmented plants from large seed had $2n$ counts near 70; 94% of the nonpigmented plants from small seeds had $2n$ counts near 49.

Although Windsor was shown to be relatively stable at $2n = 49$ and $2n = 70$, much genetic interchange and chromosomal variation was still taking place. Some reverse associations of seed size and seedling pigmentation were shown. Seedlings were found with $2n$ counts on or near $2n = 35, 49, 56, 60's, 70's, 80's, \text{ and } 105$. Of 51 plants examined only two had counts close to $2n = 86$, the number reported for the ancestral clone.

Much chromosomal variation may have been caused by intracultivar crossing. Twins were found with $2n$ counts of 49 and 74: the $2n = 49$ plant was likely apomictically produced; the $2n = 74$, likely of sexual origin. Also, the small group of putative hybrids with seed size and seedling pigmentation atypically associated has variable chromosome numbers.

Title: SMOOTH BROMEGRASS, BREEDING AND GENETICS OF

Leaders: G. M. Dunn and G. Y. Tan, New Hampshire

In a bromegrass test involving multi-clone synthetics, the superiority of Syn 1 over Syn 2 was greater in the first than in the second harvest year (approximately 0.7 tons/ha in 1970 vs. 0.2 tons/ha in 1971). The cultivars, 'Blair' and 'Saratoga,' performed relatively well both years.

Stomatal length, stomatal frequency, and pollen diameter were measured in 4N, 6N and 8N Bromus inermis. Mean stomatal lengths were 31.6 μ , 49.2 μ and 62.5 μ for mature 4N, 6N and 8N plants, respectively, with little if any overlap between 4N and 8N levels. Stomatal length is therefore recommended as a reliable index to screen for polyhaploid plants. Pollen grain diameter increased with increasing ploidy while stomatal frequency decreased, with considerable overlapping among ploidy levels for both characters.

Title: RELEASE OF ALFALFA CLONES RESISTANT TO OZONE

The Plant Science Research Division, Agricultural Research Service, USDA, announced the release of nine clones resistant and five clones highly susceptible to ozone injury on March 1, 1972. These clones were developed cooperatively by the Plant Air Pollution Laboratory and Alfalfa Investigations, Beltsville, Maryland. They are being made available for studies of plant resistance to ozone and for use in development of cultivars or hybrids with improved resistance to air pollution.

Five of the nine ozone-resistant clones were selected from MSB-CW5An2, a germplasm pool developed by 19 cycles of recurrent phenotypic selection for resistance to the following disease and insect pests: Anthracnose, bacterial wilt, common leafspot, potato leafhopper yellowing, and rust (J. Environ. Qual. 1: 106-111, 1972; Crop Sci. 9: 526-527, 1969). Four ozone-resistant clones and one susceptible clone were selected from 'Team' (U.S. Dep. Agr. ARS 34-115, 1970). Four ozone-susceptible clones were from 'Williamsburg' (Agron. J. 50: 685, 1958).

To screen for ozone sensitivity, more than 150 plants of each population of cultivar were exposed to 20 pphm of ozone for 4 hours in a fumigation chamber at 26 C, $92 \pm 2\%$ relative humidity, and 2000 ft-c luminescence (Crop Sci. 11: 114-115, 1971).

Section II

Engineering Research

Title: REGIONAL PROJECT NE-70 -- ENGINEERING SYSTEMS FOR FORAGE CROP PRODUCTION AND USE

Leaders: R. J. Rowe (Me.), Chairman, Research Committee; W. L. Kjelgaard (Pa.); D. R. Mears (N.J.) and L. F. Whitney (Mass.)

Contributors: The Maine, Massachusetts, New Jersey, and Pennsylvania Agricultural Experiment Stations

A general statement of the forage production system has been developed in the form of a flow chart (N.J.) The problem formulation represented on the chart is a major step in the development of a generalized mathematical model of forage production as it may exist in the Northeast Region. Other work has been directed toward more detailed modeling of parts of the overall system.

A mathematical model of the flow of corn silage through mechanical devices in transport and handling was developed (Pa.) The model matched various field harvesting rates and hauling distances of corn silage with numbers and types of machines and calculated the overall mechanical power and labor input per ton. A minimum energy input model of baled hay handling from field to storage including the alternative of mechanical drying has been initiated. Flow diagrams and coefficients have been determined in the process of preparing the model for computation.

Consultation with staff in Animal Science and Plant Science has led to interest in harvest, drying and processing of immature grass crops (Me.) This high protein and low fiber feed can substitute for concentrate feeds giving it a potentially high value compared to roughage. Work is underway to develop flow charts for feasible harvest and processing systems for incorporation in the regional forage system model.

Several efforts were continued in the area of forage drying. Coupling of mass and heat transfer in the modeling of the drying of biological material was found to better explain dehydration phenomena and a study of spray drying of alfalfa leaf protein powder is underway (Mass.)

Previously developed drying and material temperature rate equations were used to simulate the drying of thin or fully exposed layers of alfalfa (Me.) A summary of previous experimental results and their application to simulation of thin-layer drying was presented in a technical paper.

Protein extraction from alfalfa leaves as affected by mechanical forces is under study (Mass.) Ultrafiltration of expressed alfalfa juice was found not to be sufficiently effective. However, concentrations of 7X without appreciable denaturing make the process of interest. Seventy percent of plant-held water was removed by mechanical dewatering.

Evaluation of the integrated self-feeding silo and livestock system was continued and several improvements made (N.J.)

The technical committee has considered the relationship of these efforts to the regional forage model and has delineated areas of responsibility for each of the participating stations.

Title: ENGINEERING SYSTEMS FOR FORAGE CROP PRODUCTION AND USE (N.J.)

Leaders: D. R. Mears, G. H. Nieswand, and M. E. Singley

Evaluation of Integrated Livestock Systems: Improved modifications have been incorporated in the experimental circular dairy barn, liquid manure handling system, and self-feeder silo.

Systems Analysis Applied to Forage: Work on the development of a generalized mathematical model of the entire forage production system is continuing. A general statement of the entire problem has been proposed in the form of a flow chart. This formulation accounts for the usage of land; the selection and culture of various possible cropping systems; the allocation of resources including machinery, labor, storage facilities, and livestock; the recycling of wastes to the land; and the requirements of the livestock.

The key parameters relating to each phase of the system have been determined. Work is underway to formulate the various phases of this problem in mathematical form. It has become clear that none of the currently available package programs utilized by systems analysts is adequate for this problem and an attempt is therefore being made to compose a suitable combination of these programs, together with some new programs being developed.

Title: ENGINEERING SYSTEMS FOR FORAGE CROP PRODUCTION AND
 USE (Massachusetts)

Leaders: L. F. Whitney and C. S. Chen, Massachusetts

Work under this project contributing to the regional project has the effect of creating a new systems route by which alfalfa protein for human consumption emerges as the main product of concern with forage for animal feed as the by-product. The utilizable feed value to the cow is anticipated not to change appreciably, since not all protein can be extracted by juice expressing processes.

For mechanically separating protein as the most valuable plant constituent, a meat grinder and a heavy platen press were used. After the process the residues (alfalfa leaves and minor stems) still contained 15% crude protein or 88% of the original protein. However, 70% of the original water was removed in this way. Separating protein by repeated ultra filtration raised its concentration times from 2.8% to 7.3%. The permeate still contained 1.4-1.8% of protein.

Coupling of mass and heat transfer in the modeling of the drying of biological materials was found to better explain dehydration phenomena. Potato and rough rice were investigated with direct application to forages as with alfalfa pellets and plant parts. Stochastic modeling of crop growth prediction was found as a better method than those reported previously--for pea production data available from the literature.

A study of vegetative growth of a monocotyledon, oats (Avena sativa) was used to establish a functional relationship for correlating the rate of growth (as dry matter), under controlled conditions, with environmental parameters. At present the experiment has been extended using a dicotyledon, radish (Rapfhanus satirus) and yields of protein and carbohydrates as additional objectives. A mathematical model based on Bertalanffy's general transport equation for open systems is proposed for predicting plant growth. The equation is expanded for plant growth into a set of quasi-kinetic nonlinear differential equations. As a first approximation, the set of equations describes a carbohydrate budget of the living plant with temperature and light sensitivity. For the crop production, plexiglass growth chambers are used and the developed prediction equations are tested even under atmospheric CO₂ fertilization. The final results will produce a generalized formula for predicting plant growth and development. Provisions are included for correcting for given environmental influences.

Title: PRE-DIE MANIPULATION, DIE DESIGN AND MATERIALS, AND
POST-DIE TREATMENT IN HAY WAFERING

Leader: E. C. Schneider, Vermont

All hay wafering runs made in the reporting period were made with Series No. 11, 25% glass fiber filled Teflon dies.

Dies used for runs were full length, $1/2$ length, $3/8$ length, and $1/4$ length. Runs were made at varying pressures, with and without aftercone.

Unit density for wafers produced with fraction length dies appeared to vary more than with full length dies and was lower as wafer size increased. The resultant wafers exceeded the capacity of our balance for our method of determining unit density. Therefore, new equipment was designed and constructed utilizing the principle of water volume displacement in a calibrated cylinder to determine unit density.

Data from all runs are being analyzed in anticipation of preparation of a bulletin.

Title: QUANTITATIVE DETERMINATION OF HEAT AND MASS TRANSFER
COEFFICIENTS OF FORAGE

Leader: R. J. Rowe, Maine

Previously developed drying and material temperature rate equations were used to simulate the drying of thin or fully exposed layers of forage. The ability to model thin layer drying is viewed as a basic requirement for the modeling of complete drying systems where the mass of material within the dryer is considered to be made up of a number of thin layers, each exposed to different drying conditions and each at different moisture contents.

Following an approach similar to that used in the analysis of grain dryers, programs are being developed to predict the temperature and moisture content of forage on a step by step basis as it passes through the dryer. Forage drying systems must reflect the more rapid drying, higher temperature limits, and more difficult flow characteristics of forage.

The method used includes the effect of material temperatures on drying rate and is suited to analysis of high temperature continuous flow dryers.

A review of fluidization and its potential application to continuous flow forage drying was conducted. Some preliminary experimental work was done to define fluidization properties of chopped alfalfa in air. Further experimental work is planned using a drying chamber with mechanical agitation to enhance the fluidization process.

Section III

Entomology Research

Title: ALFALFA PESTS, BIOLOGICAL CONTROL

Leaders: G. L. Jensen and D. E. Miller, Massachusetts

The major thrust of our research during the past year has been concentrated in the area of potential weevil insect predators. For our investigations two approaches were used, one involving preliminary laboratory investigations and the second involved the development of a serological procedure which gave an indication of the origins of the gut contents of predaceous insects.

The laboratory observations gave an indication of which predaceous species could and would feed on the weevil. Although these observations were useful in determining which predators might be most intimately involved in controlling the weevils, it could not be concluded from them that they would be equally effective in the field.

The serological procedure helped to determine the number of field collected predators which had fed on the weevil. Results showed that the weevil is preyed upon by two species of predaceous stink bugs, and three species of damsel bugs. Of these the stink bugs produced the highest ratio of positive results.

Title: ALFALFA LEAF MINERS IN MASSACHUSETTS

Leaders: G. L. Jensen and W. E. Barney, Jr., Massachusetts

A survey of alfalfa leaf miner (Agromyza sp.) levels from mid-June through mid-September indicated that up to 50% of the leaflets of mature plants were infested in Berkshire County in June, while in

Franklin County about 35% were infested at the same time. Alfalfa in Hampshire and Hampden Counties was infested up to 18%, while Worcester County had only about 11% of the mature plant leaflets infested in June. Essex County alfalfa revealed less than a 10% infestation in June but rose to over 30% in July. Alfalfa in all counties was only mildly infested (less than 10%) from August to mid-September.

Title: ALFALFA WEEVIL, EFFECT OF INSECTICIDES ON PARASITES OF

Leader: A. A. Hower, Jr., Pennsylvania

A study to evaluate the impact of insecticides on parasites of the alfalfa weevil was begun in 1971. Methyl parathion, the insecticide most commonly used for alfalfa weevil control in Pennsylvania was applied on 177 acres of first-crop alfalfa at Hershey, Pa. A second area consisting of 118 acres was designated as the control. Square foot samples to estimate weevil populations, were taken weekly beginning in late April and continued until first-crop harvest. Thereafter samples were taken once a month through October. Weevil larvae and adults were dissected for parasites. Weevil larvae, adult weevils, weevil larvae containing the parasites, Bathyplectes curculionis, B. anurus, and Microctonus colesi; adult weevils containing Microctonus aethiops and M. colesi; and adult M. colesi and B. curculionis were caged on the alfalfa at weekly intervals from the date sprayed until first-crop harvest. Residue samples were taken on each sampling date.

A similar study was conducted by spraying stubble of the first crop at State College, Pa. No cage studies were conducted at this location.

Title: ALFALFA WEEVIL, EFFECTS OF RADIATION DOSE AND AGE OF IRRADIATION ON THE MATING BEHAVIOR OF

Leaders: A. A. Hower, Jr. and J. Wollam, Pennsylvania

This study was designed to evaluate the effects of a dose of gamma radiation and age at irradiation on the mating behavior, sperm transfer, and survival of the male alfalfa weevil. Mating competitiveness, copulation period, sperm transfer, and survival of 3- through 5-week old laboratory-reared male weevils were not detrimentally affected by radiation doses up to 4 kiloroentgens. Radiation doses of 5 and 6 kiloroentgens did appear to have harmful effects on mating competitiveness and survival. There appeared to be a radiation dose threshold between 4 and 5 kr

above which mating competitiveness and survival decreased sharply, and below which competitiveness and survival were no different than that observed for nonirradiated insects.

Title: ALFALFA WEEVIL IN MARYLAND (1971), INTEGRATED CONTROL OF

Leader: W. E. Bickley, Maryland

Alfalfa weevil larvae were reared at 26 C and under a 15-hour photoperiod. Adults were exposed to mated female Microctonus aethiops which oviposited in weevils during a period of 2 weeks prior to diapause. Parasitized weevils were stored at 10 C and later treated with the synthetic juvenile hormone, cis, trans-10,11 epoxyfarnesenic acid methyl ester which caused parasites to emerge from hosts. Parasites were released at 5 sites. Recoveries attributable to these releases were made in Baltimore, Montgomery, and Washington Counties. M. aethiops is known to be established in 8 counties. Present indications are that low weevil populations occurring in the Middle-Atlantic States are a result of M. aethiops and M. colesi. Work plans for 1972 call for a survey of alfalfa for determining levels of parasitism of Microctonus in relation to subsequent larval populations.

A study of an alfalfa field and the preparation of alfalfa weevil life tables were initiated. Work this year has principally centered on developing reliable methods for sampling all life stages. Data collected to this point have been submitted to computer analysis, along with weather data. A tentative predictive formula for forecasting economic injury levels is being prepared. To present, no key prediction factor has been isolated.

Title: ALFALFA WEEVIL IN PENNSYLVANIA (1971) POPULATION TRENDS AND THE DISTRIBUTION OF PARASITES OF

Leaders: A. A. Hower, Jr., Z. Smilowitz and W. G. Yendol, Pennsylvania

For the past 3 years fields were surveyed throughout Pennsylvania. The state was divided into five regions. A total of 19 sample sites was located throughout these regions. Fifty 180° sweeps with a 15-inch diameter sweep net were taken in each field weekly until first cutting and biweekly thereafter until October.

Based on the 1969 data the peak larval population has again declined in all regions except the southwest where the population has shown a steady

increase over the past 2 years. The smallest larval populations were found in the south central region (ca. 10/sweep) and the largest in the southwest (100+/sweep).

Bathyplectes curculionis was again the most active parasite and was found throughout the state. Tetrastichus incertus declined in its activity as compared to 1970. B. anurus increased its distribution and was recovered for the first time in the southwest and south central regions. Microctonus colesi has attained a foothold in the western counties. However, M. aethiops another parasite found in the adult weevil has not been found west of the central region.

Title: ALFALFA WEEVIL IN VERMONT (1971)

Leader: G. B. MacCollom, Vermont

The alfalfa weevil, Hypera postica, was first found in Vermont in 1961. By 1965 the entire state was infested, with alfalfa producers suffering severe losses in areas where the weevil was first found. In the subsequent years through 1968, weevil populations continued at high levels with severe economic impact on alfalfa producers statewide. Chemical controls from 1965 through 1969 were widely accepted and used.

In 1969 there was a significant reduction in weevil populations, and this trend has continued through 1971. As a result the necessity for chemical controls has decreased to a point where less than 4% of producers sprayed in 1971. This is a decline from a high of over 80% in 1967.

The decline in weevil populations is attributed to biological control, but recovery of parasitized populations does not completely substantiate this view.

Highest % recoveries of parasites

| | <u>1969</u> | <u>1970</u> | <u>1971</u> |
|---------------------------------|-------------|-------------|-------------|
| <u>Microctonus aethiops</u> | 42 | 3 | 75 |
| <u>Bathyplectes curculionis</u> | 0 | 25 | 35 |
| <u>Tetrastichus incertus</u> | 7 | 3 | 0.4 |

Recovery of parasites from field collected alfalfa weevil larvae and adults at previous parasite release sites ranged from the highs shown above to zero.

First release of alfalfa weevil parasites was made in 1965 and continued through 1969. All release material was furnished by USDA.

With the decline of the weevil there has been a marked increase in the incidence of an alfalfa leaf miner. To date no work has been done on this insect in Vermont.

Title: CLOVER ROOT BORER ADULTS, ARTIFICIAL DIET FOR

Leader: Robert A. Byers, Pasture Research Laboratory

Adult clover root borers (Hylastinus obscurus) were collected from infested red clover roots by a Berlese funnel technique. The adult borers were allowed to feed on an artificial agar-based diet for 30 to 60 days at 24-27 C, then they were stored in the refrigerator on the diet at 7 C. Some adults collected in September 1971, were still in excellent condition in February 1972.

Composition of the diet is as follows: agar - 2.4 g, Vanderzant-Adkisson wheat germ diet - 12.5 g, ascorbic acid - 0.35 g, methyl paraben - 0.20 g, sorbic acid - 0.20 g, Torula yeast - 0.25 g, and distilled water - 80 ml. The agar was dissolved in 60 ml of distilled water, heated to 90 C, and cooled to 60 C. The other ingredients were then mixed with 20 ml distilled water and blended with the cooled agar in a Waring blender for 30 sec. The diet was dispensed into small plastic containers with seal tight lids and stored at 7 C, until needed.

Title: CLOVER ROOT BORER, PREFERENCE FOR DISEASED ROOTS BY

Leaders: K. T. Leath and R. A. Byers, Pasture Research Laboratory

The ability of adult borers (Hylastinus obscurus), collected from field-grown plants, to select between diseased and healthy red clover roots was determined in walking bioassays. When caged with access to aqueous leachates from diseased and healthy red clover roots, 155 borers selected the leachate from the diseased roots, 18 selected the leachate from the healthy roots, and none selected the distilled water control. In several tests, nearly all borers placed on pieces of healthy roots walked to and bored into pieces of diseased roots contained within the same test chamber. In reciprocal tests no borers left pieces of diseased roots to move to healthy roots. Roots infected with Colletotrichum trifolii or Fusarium roseum were as attractive to the borers as were naturally diseased roots from the field or greenhouse. Leachates from diseased roots stimulated extensive feeding by the

borers in nearly all tests; leachates from healthy roots stimulated feeding less frequently and less extensively than did leachates from diseased roots. Olefactometer tests and preference tests in soil are currently being conducted.

Title: CLOVER ROOT CURCULIO CONTROL ON ALFALFA BY GRANULAR CARBOFURAN AS SUGGESTED BY RATE OF ALFALFA REGROWTH, ROOT DAMAGE AND YIELD

Leader: John W. Neal, Jr., USDA-ARS, Beltsville, Maryland

A 3-year study demonstrated that granular carbofuran, when applied as an early spring treatment at 2 lb actual per acre, resulted in reduced feeding damage to alfalfa roots by the clover root curculio, increased yield and faster regrowth following harvest. Treatment significantly reduced larval feeding damage on roots during the year applied, but was not effective beyond that season. Carbofuran applied annually for the 3-year period provided the greatest protection, however, an application following 1 or 2 years of no treatment still resulted in a significant increase in plant growth over untreated plots for that year. Yield data were inconsistent for treatments, however, differences among treatments were detected. No significant difference was found among the six cultivars included in the test for response to clover root curculio feeding on the basis of yield or regrowth data. Feeding damage scores indicated little or no larval resistance was present in any of the cultivars.

Title: INSECTS, GRASSLAND INVESTIGATIONS

Leader: S. R. Race, New Jersey

Northern corn rootworm control trials conducted at three locations in Hunterdon County during 1971. The objectives were: (1) to determine rootworm influence on corn growth and production, and (2) which insecticides, applied in the furrow at planting, were best for control.

Results showed each treatment reduced rootworm injury to corn roots. Rootworm-injured plants numbered 27.7% in untreated plots whereas in treated plots injured plants numbered: diazinon = 1.0%; Furadan = 0.7%; Thimet = 2.0%; Bux = 0.8%; Dyfonate = 9.6%. Yield weights in bushels of shelled corn per acre (corrected to 15% moisture content) were: untreated = 77.5; diazinon = 103.2; Bux = 99.6; Thimet = 99.4; Furadan = 97.7; Dyfonate = 82.3.

These results show that northern corn rootworms can be a significant limiting factor in New Jersey field corn production. At a rate of \$4.00 per acre for insecticide, an average return per acre of \$21.85 was realized in this test. These results helped provide the needed information to make meaningful control recommendations which will be passed along to New Jersey corn growers for the 1972 growing season.

The alfalfa weevil, once the most important economic insect species of agriculture in New Jersey (1957-1967), is now relegated to a position of insignificance. It is believed that weevil decline is due to the activity of tiny, parasitic wasps especially introduced into New Jersey for this purpose.

Title: INSECT SURVEY OF 39 CULTIVARS OF GRASSES AT TWO NITROGEN TREATMENTS

Leaders: Robert A. Byers and Gerald A. Jung, Pasture Research Laboratory

Insects were collected by sweep net from each of 39 different grass cultivars fertilized with nitrogen at 200 lb/acre and also from the same 39 cultivars with a zero nitrogen treatment. Sweep net collections were made in the early afternoon on the following dates in 1971: May 17, June 2 and 21, July 15 and 26, August 6 and 19, September 13 and October 21. The most abundant insects collected were the Diptera, frit flies, leafhoppers, grasshoppers, flea beetles, Trigonotylus ruficornis (a green plant bug), and meadow spittlebug adults.

Some species of insects were collected in higher numbers from the nitrogen fertilized treatment, other species were collected in equal numbers from both treatments, and some species were more abundant on the zero nitrogen treatment. Frit flies were most abundant on nitrogen treated reed canarygrass, timothy, and Kentucky bluegrass. Leafhoppers were collected in highest numbers from nitrogen treated Kentucky bluegrass, tall fescue, and perennial ryegrass. Orchardgrass, brome-grass, tall fescue, Lolium X Festuca, and perennial ryegrass with the nitrogen treatment had the most grasshoppers. Tall fescue and Lolium X Festuca with nitrogen treatment had the most flea beetles. Nitrogen fertilized reedtop and timothy had the most thrips. In contrast, T. ruficornis was collected in highest numbers from the zero nitrogen treatment of timothy and Lolium X Festuca. Meadow spittlebug adults were most numerous on the zero nitrogen treatment of orchardgrass, reed canarygrass, and brome-grass.

Title: PEA APHID RESISTANCE IN TEAM GERMPLASM

Leaders: T. C. Elden, R. H. Ratcliffe, and T. E. Devine, USDA-ARS,
Beltsville, Maryland

Alfalfa seedling tests conducted in the laboratory at Beltsville, Md. have demonstrated that a high level of pea aphid resistance exists in several alfalfa populations closely related to the cultivar 'Team.' This characteristic was previously demonstrated for Team in field plot tests in Maryland (1968-70) and seedling tests conducted at Manhattan, Kansas in 1969. The role that different resistance mechanisms such as tolerance, nonpreference, and antibiosis play in this response is not presently known. However, tests on mature plants have shown that antibiosis is involved in the resistance found in Team. This was expressed as increased mortality and greatly reduced fecundity of females confined on test clones.

In the seedling tests Team, 'MSHp6F' (related to Team with 5 cycles of field selection for alfalfa weevil resistance, but no laboratory selection), 'MSHp6FAN4W4' (3 cycles of lab selection for anthracnose and bacterial wilt resistance) and 'MSHp7FL2' (1 cycle of selection for weevil resistance beyond Team based on a combination of nursery and lab evaluation) were compared with the pea aphid resistant cultivar 'Kanza' and one or more susceptible cultivars. Seedling survival for these 4 entries was equal to or slightly lower than that for Kanza in both tests, but not significantly different at the 5% level. When tested at 70-75 F seedling survival for Kanza after 4 weeks of aphid feeding was 77%, while that for MSHp6F, Team, MSHp6FAN4W4 and MSHp7FL2 was 77, 76, 71 and 67%, respectively. 'Cherokee,' 'Atlantic' and 'Williamsburg' averaged 40, 40 and 17% seedling survival, respectively. When tested at 60-65 F, average seedling survival for MSHp7FL2, MSHp6F, Team and MSHp6FAN4W4 was 48, 48, 47, and 43%, respectively, as compared to 58% for Kanza and 11% for the susceptible cultivar 'Ranger.'

In addition to demonstrating the presence of high levels of pea aphid resistance in these alfalfa populations, seedling tests indicated that the level of pea aphid resistance in Team germplasm undergoing selection for disease resistance was not affected (compare seedling survival in MSHp6F and MSHp6FAN4W4). Further tests are planned to determine the role of antibiosis in resistance of these and several populations representing earlier cycles of selection in the development of Team.

Title: SITONA HISPIDULA EFFECTS ON ALFALFA AND ALFALFA-ORCHARDGRASS MIXTURES

Leaders: C. F. Gross, R. A. Byers, and R. R. Hill, Jr., Pasture Research Laboratory

Alfalfa and alfalfa-orchardgrass plots, replicated four times, were treated on May 7, 1971, with carbofuran granules at 2 lb AI/acre (2.24 kg AI/ha) to control Sitona hispidula larvae. Plots were sampled for larvae after the first forage harvest on June 17, 1971, by digging approximately $1/2 \text{ ft}^3$ ($.014 \text{ m}^3$) of soil from one site in each plot. The sifted soil from the insecticide treated plots of alfalfa and alfalfa-orchardgrass, both had a mean of 0.5 larvae per sample. Soil from untreated alfalfa had a mean of 2.0 larvae per sample and from untreated alfalfa-orchardgrass a mean of 4.7 larvae per sample. This represents a 50% reduction in Sitona larvae in untreated plots from 1970. No damage to the taproots by the larvae was observed in any of the plants in the samples. There were no significant differences in yield of forage among any of the plots attributed to Sitona. The low numbers of Sitona larvae encountered was attributed to an extremely dry April in 1971 which may have been detrimental to Sitona eggs located on the soil surface.

Section IV

Environmental Research

Title: AGRICULTURAL WASTE WATER ACCOMMODATIONS AND UTILIZATIONS BY VARIOUS FORAGES

Leaders: J. H. Axley and G. L. Miller, Maryland

The objective of this study was to observe the response of 12 forages under poultry processing effluent irrigation.

It was observed that Kentucky bluegrass has a great potential under this type system because it does not go into dormancy during the hot portion of the Maryland summers. This may be due to reduced soil temperatures brought on by evaporation from the soil, a result of frequent irrigation. The study indicated that ladino and Strawberry

clovers may tolerate intense sewage irrigation. However, these legumes do occasionally fail for short periods of time and then re-establish themselves by natural process. The forages that did not respond adequately were: timothy, alfalfa, birdsfoot trefoil, bermudagrass, zoysia, and smooth brome grass. It was found that tall fescue, and Italian ryegrass did not respond as expected from previous studies because they were harvested when too mature. This resulted in clumps of grass instead of a uniform sward even though they were harvested five times during the season. Reed canarygrass suffered from these frequent cuttings and slowly lost vigor. This study suggests that more emphasis be placed on management of forages under sewage irrigations.

Title: AIR POLLUTION RESISTANCE IN PLANTS

Leaders: T. E. Devine, R. K. Howell, and C. H. Hanson, USDA-ARS, Beltsville, Maryland

Three experimental populations, MSA-CW3An2, MSB-CW5An2, and MSHp6F-An2W2, and one cultivar 'Team' each of which had been partially selected for disease resistance under greenhouse conditions at Beltsville, Md., were compared with 10 cultivars for sensitivity to ozone damage. Plants were exposed to 20 parts per hundred million (pphm) v/v for 4 hr at 26 C, 92% relative humidity, and an illumination of 2000 ft-c. The cultivar Team and the three experimental populations developed partially in greenhouses and routinely selected for resistance to foliar injury were more tolerant of ozone than cultivars not selected. This demonstrates the effectiveness of greenhouse selection, during periods of high levels of air pollution, in the development of plant cultivars resistant to phytotoxicants.

On March 1, 1972, the Plant Science Research Division released nine clones resistant and five clones highly susceptible to ozone injury for studies of plant resistance to ozone and for use in development of varieties or hybrids with improved resistance to air pollution.

Title: FEED ADDITIVES, FATE IN FEEDLOT MANURE APPLIED TO PASTURES

Leaders: D. A. Dinius and R. H. Hart, USDA-ARS, Beltsville, Md.

Plots of alfalfa, orchardgrass, tall fescue, and Kentucky bluegrass were fertilized with 22 metric tons/ha, dry weight, of feedlot manure. Different lots of manure were spiked with Ronnel, chlortetracycline,

and diethylstilbestrol, alone or in combination, in the amounts normally found in manure from cattle fed these materials as feed additives, and in 1000 times these amounts. Checks were provided by manure free from additives, and by inorganic fertilizer at a rate providing about the same amount of P and K, and half as much N, as the manure. Forage yields of the grasses, cut every 2 weeks, were 65% higher under inorganic fertilizer than under manure, with no apparent differences in stand. Soil samples were taken in December and these and forage samples will be analyzed for additives and nitrogen. Carryover effects of the manure will be evaluated in 1972.

Title: MANURE, DAIRY AND POULTRY, DISPOSAL AND UTILIZATION BY
LAND APPLICATION

Leader: R. W. Wengel, Connecticut (Storrs)

The application of poultry manure to soil lysimeters at 60 and 120 tons DM/acre resulted in poor corn germination and reduced corn silage yields by 15 and 34% respectively, compared to conventional fertilization with inorganic fertilizers. These levels of manure applications resulted in very high soil and drain water nitrate levels throughout the growing season and into late October. Nitrate concentrations in corn tissue will be determined from harvest samples to ascertain if potentially toxic levels of nitrate are present. This work is being continued to study long-term effects of application and a study involving pretreatment of poultry manure in an oxidation ditch with subsequent land application has been initiated.

Title: MANURE AND N EFFECTS ON CORN YIELD AND CHEMICAL COMPOSITION
OF SOIL WATER

Leaders: J. L. McIntosh and K. E. Varney, Vermont

Plot studies began in 1965 on a Pantton Clay soil in the Champlain Valley to determine the effects of increasing rates of manure (0, 10, 20, and 30 tons/acre) and N (0, 50, 100, 150, and 200 lb/acre) on growth, yield, and nutrient uptake of continuous corn were continued. A similar set of plots was established on a Calais silt loam (derived from glacial till) in 1970 and will continue for 5 years. Effects of manure and N treatments on corn and soil have been summarized and prepared for publication.

The value of manure for corn on the clay soil in all but wet years was greater than that which could be attributed to its nutrient content. Application of manure significantly increased aggregate stability as measured by the wet sieve method. The 200 lb/acre application of N, on the other hand, significantly decreased aggregate stability except on plots receiving the highest rate of manure application.

Average values for analysis of soil water showed that 30 tons/acre of manure increased nitrate-N by 9.8 ppm over check at 80 cm depth and 0.56 ppm at 160 cm. On the other hand, 200 lb/acre of fertilizer N increased nitrate-N 46.8 ppm at 80 cm depth and 8.1 ppm at 160 cm. These data show the value of manure as a soil amendment in northeastern soils and illustrate that moderate applications of nitrogenous fertilizer may lead to nitrate leakage into the ground waters.

Title: NITRATE QUANTITY AND MOVEMENT IN TWO CONNECTICUT SOILS

Leaders: R. W. Wengel and G. F. Griffin, Connecticut (Storrs)

A study was initiated in 1970 to investigate the quantity and movement of nitrate (NO_3) in two Connecticut soils treated with high and low levels of inorganic nitrogen (N) fertilizer. The soils were (a) a Woodbridge fine sandy loam which has a fragipan at about the 2 foot depth, and (b) a Charlton fine sandy loam which does not have a fragipan. Nitrogen, as ammonium nitrate, was added at rates of 0 and 200 lb N/acre. Soil water samplers were installed at depths of 1, 2 and 4 ft at both upslope and downslope positions. Samples of soil water were taken at weekly intervals throughout the growing season and analyzed for $\text{NO}_3\text{-N}$. Plots were seeded to silage corn.

On both soils the NO_3 levels in the soil water were relatively high in the early summer and low in late summer. The reduction was most evident for the 1-ft depth on the Woodbridge soil treated with 200 lb N/acre, where NO_3 values dropped from 131 ppm $\text{NO}_3\text{-N}$ on June 14 to 2.2 ppm $\text{NO}_3\text{-N}$ on October 11. On the Charlton soil the change was from 13.5 to 2.0 ppm $\text{NO}_3\text{-N}$ over the same time period. At the 4-ft depth, on the Woodbridge soil treated with 200 lb N/acre, the change in NO_3 levels over the same time period was from 10.5 to 5.2 ppm. The NO_3 levels on the corresponding Charlton plots changed from 2.1 to 1.8 ppm. Nitrate values at the 2-ft depths were intermediate between those at the 1- and 4-ft depths. Nitrate levels in soil water on plots receiving no N applications were about the same or slightly less than those on plots treated with 200 lb N/acre.

Section V

Growth, Physiology, and Climatic Effects

Title: ROOT GROWTH OF LEGUMES

Leader: W. A. Kendall, Pasture Research Laboratory

The immediate objective of this program was to develop techniques to measure root growth rates as affected by plant genotype, climate, and soil pathogens. The roles of these factors in the production of forage plants may then be evaluated.

Equipment was developed for culturing plants in nutrient solution on slant boards. The boards were covered with a synthetic cloth and wetted either by continuous automatic irrigation or an absorbent material was placed over the root and wetted daily by hand application.

A weight displacement technique was developed to allow nondestructive measurements of the plant root and shoot. An individual plant was transferred from the slant board to a balance to first measure total fresh weight and secondly the weight with the root submerged in nutrient solution. The weight of the plant with the root submerged was used to estimate fresh weight of the top. The difference between the total weight and the submerged weight was used to estimate fresh weight of the root. Generally good correlations were obtained in comparisons of values obtained by the root submerged technique and the measurements of isolated roots and shoots.

Title: RELATIONSHIP OF ALFALFA YIELDS TO SPECIFIC LEAF WEIGHT, TILLERING, LEAF AREA, AND PHOTOSYNTHESIS

Leader: Richard H. Hart, USDA, ARS, Beltsville, Maryland

Six populations of alfalfa, three selected for high specific leaf weight (SLW) and three for low SLW, were planted in the field in 1970. Each population of 24 clones was planted in quadruplicate plots, with three plants of each clone per plot, spaced 15 cm apart. Forage yields from four harvests in 1971 were 19.6 metric tons (MT)/ha for the high SLW populations, with no differences among the three populations, vs.

18.2 MT/ha for the low SLW populations. One of the low populations yielded as well as the high populations, but the other two yielded significantly less. Tiller numbers and length, and leaf area and total weight of the longest tillers, were determined, and the influence of these factors on yield will be examined. SLW and net photosynthesis will be measured on all clones in the growth chambers this winter.

Title: DIURNAL CHANGE IN SPECIFIC LEAF WEIGHT OF MEDICAGO SATIVA L.
AND ZEA MAYS L.

Leader: N. J. Chatterton, USDA, ARS, Beltsville, Maryland

Diurnal changes in specific leaf weight (SLW) and total nonstructural carbohydrates (TNC) were observed in alfalfa (Medicago sativa L.) and corn (Zea mays L.). In addition to the diurnal pattern of increasing SLW and TNC during the day, immediate changes in SLW and TNC were induced by fluctuations in incident light intensity. Since diurnal change in SLW of fully expanded leaves reflects a change in leaf assimilate content, investigation of the use of change in SLW is suggested as a selection criteria for efficient translocation.

Title: FACTORS AFFECTING THE CARBOHYDRATE COMPOSITION OF FORAGES

Leaders: G. A. Jung and C. F. Gross, Pasture Research Laboratory;
D. E. Brann, West Virginia

Nonstructural carbohydrate concentration was high in timothy, smooth brome grass, reed canary grass, tall fescue and perennial ryegrass at the vegetative growth stage in spring. Kentucky bluegrass and redtop contained relatively low concentrations and orchardgrass an intermediate level of nonstructural carbohydrates.

Nonstructural carbohydrate concentration decreased with an advance in growth stage, with higher summer temperatures, and with nitrogen fertilization. The grass species, however, were affected to different degrees by these factors.

Lignin and fiber concentrations in the leaves and stems of crownvetch increased with an advance in growth stage. The rate of increase, however, often varied among locations and appeared to be related to growth.

Although leaf and stem composition usually were affected in a similar manner by maturation and weather, lignin concentration in stems was affected only by growth stage in spring, whereas lignin in leaves and fiber in leaves and stems during this period were affected by complex interactions involving growth stage and environment.

Title: SELF-INCOMPATIBILITY IN RED CLOVER

Leader: W. A. Kendall, Pasture Research Laboratory

Most clovers usually do not produce self-seed which excludes inbreeding from clover improvement programs. Some self-seed can be obtained if the plants are maintained at a high temperature during anthesis. An excised stem technique has proven convenient to provide the temperature treatments, but seed yields were variable. The objective of the present research was to improve seed yields when inbreeding red clover by the excised stem technique.

Seed production was greatest in a temperature range of 35 ± 3 C during anthesis. Illumination of the buds and flowers did not affect seed set. Flower stems excised before anthesis produced more seed than intact plants. The addition of calcium, but not proline, to media used to culture excised stems was beneficial to seed set. Treatment of 1 cm of the cut ends of excised flowering stems with steam, charring in a gas flame, liquid nitrogen, or mechanical crushing did not influence yield as compared to no treatment other than excision with scissors. Seed yields were not correlated with growth of pollen through the styles, which indicates that some seed failures occur after pollen has grown through the styles as well as during pollen growth.

Title: EFFECTS OF TILLERING AND COOL NIGHTS ON PHOTOSYNTHESIS AND CHLOROPLAST STARCH IN PANGOLA

Leaders: N. J. Chatterton and G. E. Carlson, USDA, ARS, Beltsville, Maryland

Clonal propagules of Digitaria decumbens Stent, were given night temperature treatments of 30, 10, 8, and 6 C with day temperatures of 30 C. Chloroplasts of actively tillering plants accumulated little starch and NCE (net carbon dioxide exchange) rates showed no effect of cool nights. In contrast, the chloroplasts of nontillering plants

accumulated starch during the day thereby necessitating translocation during the dark period. When night temperatures were cool, however, starch translocation was reduced and chloroplasts maintained a high starch content. The greater chloroplast starch content in nontillering plants following cool nights was negatively correlated (1% level) with NCE rates. Plants developing new tillers and therefore possessing large assimilate sinks had faster NCE rates than nontillering plants.

Title: EFFECTS OF INTRASPECIFIC COMPETITION ON THE GROWTH AND
 COMPOSITION OF TIMOTHY

Leaders: Morris Rosen and J. A. Balasko, West Virginia

Unelongated vegetative shoots of timothy were planted at densities of 22, 88, 422, and 1700 plants/m² in a greenhouse to determine the effect of spacing on growth and chemical composition. Nitrogen was applied at two rates, and harvests were made at ear-emergence and at anthesis. Low N plots received 56 kg/ha of N. High N plots harvested at ear-emergence received 4 applications of 224 kg/ha of N at 2-week intervals, and high N plots harvested at anthesis received six applications of 224 kg/ha at 2-week intervals. Measurements of plant height, inflorescence length, leaf area, leaf number, and secondary shoot number were made for each harvest. Herbage, stubble, and root weights were recorded and ground samples of these three fractions were analyzed for total nonstructural carbohydrates (TNC), and herbage samples were analyzed for N, P, K, Ca, Mg, Mn, Fe, B, Cu, Zn, Al, Mo, Sr, Ba, Na, and crude fiber.

On a per plant basis, growth measurements and plant weights were greatest for the lowest plant density. However, on an area basis, plant weights were greatest for the highest density. Nitrogen did not have a significant effect on plant height. Numbers of secondary shoots were greatest at the lowest planting density, at the high N level, and at the anthesis harvest. TNC percentages in the herbage were greatest at the highest density. Herbage N, P, K, Mg, Fe, Cu, and Zn percentages decreased as plant density and plant age increased.

Title: ECOLOGY OF GRASSES AND LEGUMES

Leader: M. A. Sprague, New Jersey

The objective of the study was to determine the range of variations in the microclimate of the biosphere as affected by topography and the influence of these differences on plant growth and development.

Nearly all of our climate data are collected over level ground yet most of our land area consists of sloping land. Whether in turf, roadsides, building sites or crop production areas good plant growth can be obtained only if the variations in the climate due to slope and exposure are well understood.

During the past season monitoring equipment was installed on a sod-covered truncated pyramid, the sides of which present north, south, east and west exposures and with slope equal to the local latitude of $40^{\circ}20'$. Microclimate data in the biospheres were collected as soil temperature at 1, 4, and 8 inch depths, air temperature one inch above the soil, soil moisture at 2 and 8 inch depths, dew and precipitation. Major differences in both climate and growth of seeded species were observed on the 4-slope exposures in 1971. Equipment for integrated net solation-radiation measurements was installed to determine the influence of the energy budget on other elements of the microclimate and on plant growth. Clonal material of four ecotypes of T. repens is being produced for use in determining growth response in 1972. Determinations will be made of carbohydrate and protein contents of plants grown at different locations during spring, summer and fall seasons.

Title: ENVIRONMENTAL STUDIES WITH PLANTS

Leaders: A. M. Decker and J. W. Walker, Maryland

Funk Gl7A field corn was grown at three fertility levels (200-0-0, 200-100-200, and 200-200-400 lb/acre of $N-P_2O_5-K_2O$) on field plots with soil temperatures maintained at ambient, $15^{\circ}C$, $21^{\circ}C$, and $32^{\circ}C$. Plants were started in small paper containers in the greenhouse and grown to the 3-leaf stage. Uniform plants were selected, removed from the container and transplanted into the field where soil temperature differentials were already established.

Individual plant measurements of plant height and leaf development were made each week until harvest. Date of tassel emergence, silking, etc., were also noted. Treatments were harvested at the medium dent stage. Yields, percent dry matter, and mineral content of various plant parts are being determined from harvested material.

Data are not complete, but general statements regarding treatments can be made. Growth rates (height and leaf development), dry matter yields (including grain), and maturity date were all affected by soil temperature and fertility level. Date of maturity was shifted more than 3 weeks. Plants that matured later had a higher final height. Plants at 15 C did not reach mid-dent before the experiment terminated. Grain yields per plant varied from a low at 15 C of less than 5 grams to over 130 grams on the warmer soils. A reduction in grain yields occurred at 32 C. Calcium deficiency also occurred at 32 C.

Section VI

Management and Production

Title: IMPROVEMENT OF ALFALFA FORAGE QUALITY AND YIELD FOR DEHYDRATION

Leaders: J. B. Washko and F. E. Lukezic, Pennsylvania

In the fourth harvest year from seeding, only 19 of 30 cultivars produced sufficient forage for harvest. The five highest yielding cultivars in the fourth year were 'Waterman-Loomis 305,' 'Cayuga,' 'Iroquois,' 'Dawson,' and 'Vernal.' WL 305 produced approximately 2 tons of dry matter per acre more than the standard cultivar, 'Buffalo,' favored by the dehydrators. Differences among harvest schedules of 25 days, 30 days, 35 days, and 40 days were minor in the third harvest year when these schedules were imposed on 'Saranac' and Iroquois alfalfa varieties which reached 1/10 bloom prior to removal of the initial harvest.

Title: RESEEDING ALFALFA IN WINTER-INJURED STANDS

Leaders: C. S. Brown and R. F. Stafford, Maine

An overseeding study was initiated in spring 1970 following the extensive winterkilling of 1969-70. This study tested the effectiveness of the packer seeder in reestablishing alfalfa in a 2-year-old stand containing only moderate amounts of timothy.

The following treatments were imposed in early May: (1) untreated check, (2) seed of 'Iroquois' alfalfa sown on the undisturbed soil surface, (3) seed of Iroquois alfalfa sown after scarification of the soil by light disking. A standard 5-ft Brillion seeder was used.

Good to excellent alfalfa stands resulted from overseeding. Best results were obtained in the soil scarification treatment. Dry matter yields of alfalfa ranged from 1.5 to 2.0 tons per acre during the 1970 season.

A conventional 3-cut harvest system was used in 1971. The no-overseed check plots produced an average yield of 3.8 tons alfalfa dry matter, indicating considerable natural recovery from the previous winter injury. The overseeded plots produced an average of 4.7 tons of alfalfa dry matter per acre. No significant differences were observed between the packer-overseed and the disk + packer-overseed treatment.

Title: MORPHOLOGY, PHYSIOLOGY, AND CULTURAL RESPONSE OF PERENNIAL FORAGES

Leaders: M. J. Wright and R. R. Seanev, Cornell University

Seeding year cutting management influences forage yields of 'Saranac' and 'Iroquois' alfalfa in the second harvest year. However, the second year yield advantage of less intensive seeding year cutting treatments decreases in the third and fourth harvest years. Studies to date suggest that under favorable climatic conditions, early spring alfalfa seedings can be harvested 10 to 12 weeks after planting and second and third harvests taken at 6 to 7 week intervals without adversely affecting production in subsequent harvest years. Date of fall harvest in the seeding year has not influenced persistence or yield in the second harvest year.

Title: PERSISTENCE AND COMPETITIVENESS OF BERMUDAGRASS IN PENNSYLVANIA

Leader: G. A. Jung, Pasture Research Laboratory

Bermudagrass stolons were killed by ambient temperatures before December 1. Freezing bermudagrass rhizomes at -4 C in mid-December produced about the same amount of injury as freezing alfalfa at -8 C.

Title: PRODUCTION OF RYEGRASS FORAGE UNDER CONNECTICUT CONDITIONS

Leader: D. W. Allinson, Connecticut (Storrs)

Fall seedings of Michigan State University's experimental allotetraploid ryegrass (MSU Exp. 1) were made in both 1969 and 1970. The 1969 seedings were made at four dates, i.e., August 8, 15, 25, and September 12. Plots were clipped once following seeding, either on October 10 or October 24. The plots survived the 1969-70 winter and in 1970 were fertilized with 200 lb N/acre and harvested four times. These plots did not survive the 1970-71 winter. Fall seedings in 1970 were made on three dates, i.e., August 24, 31, and September 7. Plots were either clipped once following seeding, on October 28, or were not clipped at all. These plots survived the 1970-71 winter and in 1971 were fertilized with either 200, 300, or 400 lb N/acre and were harvested five times. These stands appeared to be in excellent condition in the fall of 1971.

The late date of fall cutting in 1969 significantly ($P < 0.01$) lowered DM yields in 1970. Plots cut on October 10 in 1969 yielded 3.51 tons DM/acre in 1970, while plots cut on October 24 in 1969 yielded 2.65 tons DM/acre in 1970. Date of seeding in 1969 also influenced yields in 1970. Acreage yields from the August 8, 15, 25, and September 2 dates of seeding were 2.48, 3.31, 3.66, and 2.87 tons DM/acre, respectively.

Fall cutting in 1970 did not affect yields in 1971. The maximum yield obtained from the fall clipping was 0.7 tons DM/acre, realized from the August 24 seeding. Date of fall seeding did not significantly influence the 1971 yields. However, yields were substantially affected by nitrogen level. Mean yields from nitrogen treatments of 200, 300, and 400 lb N/acre were 4.1, 4.6, and 5.0 tons DM/acre.

Title: SWITCHGRASS (PANICUM VIRGATUM L.) EVALUATION IN PENNSYLVANIA

Leader: C. C. Berg, Pasture Research Laboratory

The production of forage by a warm-season grass species (switchgrass, Panicum virgatum L.) was compared with cool-season grasses in Pennsylvania. Dry matter yields were obtained from two cultivars of tall fescue (Festuca arundinacea Schreb.) and orchardgrass (Dactylis glomerata L.) and three cultivars of switchgrass in 1969. Two other cultivars of switchgrass failed to become established and another two

did not survive the first winter. Plots were harvested at approximately monthly intervals from May 15 to September 15, 1969.

Orchardgrass and tall fescue began growing much earlier in the spring, continued to grow later in the fall, and produced 3200 to 5000 kg/ha more dry forage over the entire season than switchgrass. During mid-summer the switchgrass varieties produced as much or more dry matter than the cool-season grasses; however, a high value must be placed on the production of forage at this time of year to justify considering switchgrass as a forage species in the cool humid northeastern United States. Yield data were limited to one harvest year (1969) because the switchgrass did not survive the following winter.

Title: HARVEST MANAGEMENT OF CROWNVETCH-TALL FESCUE MIXTURES

Leader: A. M. Decker, Maryland

Clipping management studies of 'Penngift' and 'Chemung' tall fescue mixtures were continued for the second harvest season (1970 Annual Report, p. 44).

Penngift was again superior to Chemung with the latter being almost eliminated from the more severe cutting treatments. Frequent harvesting at a 1.5-inch stubble was the most detrimental treatment with regard to both total forage yield and percentage of crownvetch in the mixture. This treatment also had a greater influx of weeds. Best overall crownvetch stands appeared to be on those plots harvested at 2.5 inches at the pasture frequency (5 harvests per season). However, total forage yields were higher for the less frequently harvested material.

Title: MANAGEMENT EFFECTS ON MORPHOLOGY AND PHYSIOLOGY OF TIMOTHY AND REED CANARYGRASS

Leader: J. B. Washko, Pennsylvania

Orchardgrass outyielded timothy in both total seasonal yield and aftermath production, regardless of cutting management. Aftermath removal, each time plants of these species attained 4 to 6 inch heights, resulted in significant decreases in total yield, aftermath yield, TDN, and digestible protein. Aftermath removal at plant heights of 20 to

22 inches resulted in higher total yield and aftermath production. Delaying initial harvest of both species from the transition to anthesis stage increased total seasonal yield 18% but decreased aftermath production 34%. Removal of the first harvest at the transition stage reduced carbohydrate content of the stubble to 4-5%. Removal at the boot stage increased carbohydrate content of timothy 16 to 20% and orchardgrass only 1%. Carbohydrate content of orchardgrass at the anthesis stage increased 6 to 8%.

Title: CROP RESPONSE TO SOIL FERTILITY AND IRRIGATION

Leader: N. A. Clark, Maryland

Corn for both silage and grain was grown in a double crop sequence with barley harvested as silage. Corn was also grown as a single crop followed by winter fallow. Each crop was grown under irrigated and nonirrigated conditions. The crops under both irrigation regimes received three different fertilizer levels: half soil test requirement, soil test requirement, and double soil test requirement.

Rainfall from April to October totalled almost 40 inches with nearly 8.5 inches in May and almost 13 inches in August. This made irrigation ineffective, although 6 inches of irrigation water were applied during June and July. A severe hailstorm occurred on August 15 resulting in an average 35% reduction in yield of all crops over previous years. There were yield responses to the fertilizer applications. Fertilizing at the soil test requirement level gave yields approximately 40% higher than the one-half soil test level. Crop yields were only slightly higher when fertilized at the double soil test level compared to the soil test level.

Title: PHYSIOLOGICAL RESPONSES OF ALFALFA AND ALFALFA-BROMEGRASS MIXTURES TO NITROGEN AND CUTTING TREATMENTS

Leader: D. W. Koch, New Hampshire

A field study using a split-plot randomized block design was established in August 1971. Main plots consist of 2 stages of maturity harvests. Subplot treatments consist of brome grass at 4 nitrogen levels (0, 80, 160, and 240 lb/acre) and with alfalfa at 3 nitrogen levels (0, 40, and 80 lb/acre). Two tons of lime, 200 lb of P_2O_5 , and

100 lb of K_2O per acre were applied previously. Yield, regrowth, persistence, and species composition will be evaluated. Time course photosynthetic and respiration rates will be related to yields.

Title: PHOSPHORUS-POTASSIUM NUTRITION OF ALFALFA

Leaders: G. O. Estes and J. R. Mitchell, New Hampshire

The objective of this study, encompassing a split plot randomized block with five replications, was to determine the effectiveness of a single, basal phosphorus (P) fertilizer application (main plots; 0, 100, 200, 400 lb/acre P_2O_5) and differential yearly potassium (K) applications (split plots; 50, 100, 200, 300, 400 lb K_2O /acre) on alfalfa production. Over a five-year period, soil levels of P and K will be correlated with plant tissue levels. Field plots (5 ft x 20 ft) were seeded on August 16, 1971, following broadcast limestone (2 tons/acre) and potassium (100 lb K_2O /acre) to the experimental area, and establishment of the different P_2O_5 treatments. One month after seeding, marked visual responses to P were apparent. Initial soil samples were taken on October 15, 1971, and subsequent samples will be taken each spring and at time of harvest and correlated with plant tissue levels of selected nutrients. Yield, physiological measurements (photosynthesis, respiration), disease resistance, and winterhardiness will be evaluated.

Title: POTASSIUM FERTILIZATION AND FREQUENCY OF CUTTING IN RELATION TO ALFALFA YIELDS IN CONNECTICUT

Leaders: D. W. Allinson and G. F. Griffin, Connecticut (Storrs)

This experiment was initiated in 1968. 'Iroquois' alfalfa was fall seeded in a Charlton soil having a soil test potassium level of 264 lb K/acre. Experimental treatments included five cutting frequencies--2, 3, 4, 5, and 6 cuts per season--and five potassium fertilization rates--0, 100, 200, 300, and 400 lb K_2O /acre--which were replicated six times. Potassium fertilizer level did not significantly affect dry matter (DM) yields in 1969. Cutting alfalfa 5 or 6 times in the 1969 growing season resulted in the loss of stands. Yields from the 2, 3, and 4 cutting systems were 4.82, 4.53, and 4.78 tons DM/acre, respectively.

Yields in 1970 were low, primarily the result of a long summer drought. Yields from the 0, 100, 200, 300, and 400 lb K_2O /acre treatments were 2.53, 2.67, 2.73, 2.87, and 2.83 tons DM/acre, respectively. Due to the loss of stands where the 5 and 6 cutting systems were used in 1969, harvests from these plots were not taken in 1970. Mean yields from the 2, 3, and 4 cutting systems were 2.62, 2.85, and 2.71 tons DM/acre.

In 1971 distinct trends were evident in response to potassium fertilization. Mean yields of 3.21, 3.56, 3.73, 3.93, and 3.82 tons DM/acre were obtained from the 0, 100, 200, 300, and 400 lb K_2O /acre treatments, respectively. Mean yields of 3.75, 3.70, and 3.50 tons DM/acre were obtained from the 2, 3, and 4 cutting systems respectively.

This experiment will be continued for one more year. Tissue samples have been taken from all treatments at all harvests and analyzed for potassium content. Uptake and removal of potassium over the 4-year period will be calculated and related to alfalfa productivity.

Title: EFFECTS OF FERTILIZATION ON INTAKE, DIGESTIBILITY, AND METABOLISM OF ORCHARDGRASS BY SHEEP IN DIFFERENT PHYSIOLOGICAL STATES

Leader: R. L. Reid, West Virginia

Orchardgrass under four fertilization treatments (56 kg N/ha; 168 kg N/ha; 504 kg N/ha; 504 kg N/ha + Zn, Cu, Mo, Co, S) was fed as cut herbage at four growth stages (vegetative-boot, heading, full bloom, seed) to lactating ewes, dry ewes, and yearling lambs. The effect of oral dosing of magnesium was also determined. Dry matter digestibility of herbage by the wethers was significantly affected by growth stage but not by level of nitrogen fertilization. Level of ad libitum intake decreased significantly for all groups of sheep from the vegetative to the full bloom stage; fertilization had a lesser effect. There were no significant differences in intake (on a metabolic size basis) between the dry ewes and wether lambs, but the lactating ewes had a markedly higher intake (about 40% greater over all treatments) than the dry ewes. Oral dosing with magnesium affected intake in some, but not all, trials. The relationship of digestibility and intake to nitrogen, mineral, and fiber components of the forage, and to levels of blood components in the sheep, is being determined.

Title: NUTRITION, SOIL, AND HERBAGE INTERRELATIONSHIPS

Leader: D. J. Horvath, West Virginia

Data from the third year of the comparison of dolomite and calcite as they affect orchardgrass Mg levels and serum Mg levels of ewes grazing spring pastures have been compiled. The significantly ($P < 0.05$) smaller fraction of ewes classified as "in danger" reported for dolomite on Gilpin soil in 1970 failed to recur in 1971. Serum Mg fell significantly in the first 72 hr on pasture, as before, and the expected soil treatment interaction was observed. Forage Mg reached 0.19% (dry matter basis) on the Ernest soil with dolomite which closely approaches the "safety limit" of 0.2% (mean of five clippings: Dolomite, 0.18 ± 0.02 ; Calcite, $0.15 \pm .01$) whereas on the Gilpin soil the mean of both treatments was 0.11% Mg.

It appears that (1) one or two additional years of study will be required and (2) unlike several European reports, no strong trend can be expected in the response to Mg on several West Virginia soils within a 3-year period.

Title: MEASURING THE NUTRITIVE VALUE OF FORAGE CROPS

Leaders: R. L. Reid and Amy J. Post, West Virginia

A study was completed on the effects of N, K, and Zn ($3 \times 3 \times 3$) fertilization on the in vitro dry matter digestibility (IVDMD) and composition of orchardgrass at three growth stages. Fertilizer treatment or level had little effect on IVDMD. Levels of soluble carbohydrate (CHO) were low and affected primarily by growth stage and level of N. Advancing maturity increased, and higher N levels decreased, cell-wall components. In a multiple regression analysis of IVDMD against cell-wall constituents (CWC), soluble CHO, K, crude protein (CP), Zn, and Si; CWC, soluble CHO, K, and CP were significant factors, CWC being most influential. Stage of growth and fertilizer treatment had significant effects on the macro- and micro-element composition of the orchardgrass.

In vitro analyses were completed on samples of Ugandan grasses and legumes of known digestibility and intake. This work will be reported in the review of the new project. Analysis is in progress on cell-wall, fiber, nitrogen, and mineral composition. Trials were also carried out in 1971 to examine further the influence of high levels of nitrogen fertilization, and of oral dosing with magnesium, on the nutritive value of cut orchardgrass fed ad libitum at four growth stages to lactating ewes, dry ewes and wether lambs.

Title: EFFECT OF N-FERTILIZATION AND MATURITY OF ORCHARDGRASS ON YIELD, PLANT COMPOSITION, AND SILAGE FERMENTATION

Leaders: H. Fenner and W. G. Colby, Massachusetts

Three year old, pure stands of orchardgrass sufficiently fertilized with K, P, Ca, and Mg and treated with nitrogen (ammonium nitrate) at 0, 35, 70, 105, and 175 kg/ha were harvested at six stages of maturity and five corresponding aftermath growths. After cutting the first growth, each series of five plots was fertilized with 70 kg/ha N. The aftermath was cut when sufficiently regrown. Yields, contents of common feed nutrients, fructosans, Ca, Mg, K, and buffering capacity were determined in the 55 samples. Representative chopped aliquots were ensiled in quart-size mason jars, stored for 90 days at a temperature of 22 C and at 4 C thereafter, until analyzed for changes and losses of nutrients and for products of fermentation.

Except for cuttings at early joint and early bloom stages of the first growth, where yields paralleled N-fertilization rates, highest dry matter yields were from plots fertilized at 105 kg/ha. Dry matter yields from first growth and corresponding aftermath combined were highest when harvested at the milk stage and fertilized at 105 kg/ha N.

In the first growth N-fertilization raised linearly percentages of crude protein, true protein, ash, ether extracts and potassium. Crude fiber, yield and buffering capacity rose to highest concentrations at 70 or 105 kg/ha N, but declined slightly at 175 kg/ha N. Increased N-fertilization lowered linearly dry matter, proportions of true protein in the crude protein, N-free extracts, and fructosans. Average Mg contents declined with N-fertilization, were lowest at 70 kg/ha N, but rose to highest values at 175 kg/ha N. Average Ca concentrations in orchardgrass were affected little by N-fertilization.

In samples of the first growth maturity raised contents of dry matter, crude fiber and the yields and lowered crude protein, true protein, ash, ether extracts, fructosans, Ca, Mg, K, and buffering capacity. In spite of uniform N-application after the first growth, the carryover of the different N-applications from spring was still noticeable in the aftermath. Effects on composition were the same as reported for the first growth. Since time spans for regrowth were inconsistent, composition of samples from different regrowth cuttings were irregular and not suitable for comparison with samples from the first growth.

Described results will be correlated with corresponding data from the silage studies.

Title: INFLUENCE OF N, P, AND K FERTILIZATION ON THE FALL GROWTH AND COMPOSITION OF KY 31 TALL FESCUE

Leaders: J. A. Balasko, West Virginia

A field study was initiated in the fall of 1971 to measure the effect of N, P, and K on the fall growth and chemical composition of Ky 31 tall fescue. Sixty kg/ha of N, P, and K were applied in factorial combinations on October 9. Sixty kg/ha of N increased herbage growth between October 9 and December 15 by 100% and herbage dry-matter percentage by 6%. One-half ton of dry (70 C) herbage was produced between these two dates at the high N level. P and K had no significant effect on dry-matter yields in the first year of the study. Chemical analyses of the herbage have not been completed.

Title: NUTRITIVE EVALUATION OF FALL-MAINTAINED FORAGES AS AFFECTED BY SOIL TEMPERATURE AND NITROGEN FERTILIZATION

Leaders: K. A. Archer and A. M. Decker, Maryland

Field studies have been undertaken to determine the effects of nitrogen fertilization and differential soil temperature regimes on the decline in quality of fall maintained tall fescue and orchardgrass. In the initial experiment, a factorial combination of 3 nitrogen levels (0, 50, and 100 kg N/ha) and the two species were examined in a randomized block design. Samples of the forages were taken at 3 sampling dates during fall and early winter.

The following parameters were measured: dry matter yield, percentage of green and dead matter in the sward, and digestibility of the dry matter. Neutral and acid detergent fiber, lignin, and silica analyses were also made on the forages.

In the following year, a similar experiment was designed which included 4 soil temperature regimes (50 F, 70 F, 90 F, and controlled ambient temperatures), 2 nitrogen levels (0 and 100 kg/ha) and the two forage species. This was designed as a split-plot with temperatures being the main plot.

Similar measurements were made in this experiment as in the previous year. The analyses have not as yet been finalized. However, it does appear that tall fescue may produce more dry matter of higher quality than orchardgrass during autumn. Yield and forage quality tended to be increased with application of nitrogen. The effect of temperature has not been assessed at this stage.

Title: CROWNVETCH-GRASS MIXTURES VS. GRASS PLUS NITROGEN AT TWO STUBBLE HEIGHTS

Leader: Richard H. Hart, USDA, ARS, Beltsville, Maryland

'Kentucky-31' tall fescue and 'Potomac' orchardgrass, in mixtures with 'Penngift,' 'Emerald,' or 'Chemung' crownvetch, or alone and fertilized with 112 or 224 kg/ha of nitrogen, were cut every 2 weeks to stubble heights of 5 or 10 cm. Yields for 1971, the sixth year after establishment and the fourth year of harvest, are given in MT/ha in the table.

| Stubble height (cm) | Grass | Crownvetch cultivar | | | Nitrogen kg/ha | |
|------------------------|--------------|---------------------|---------|---------|----------------|---------|
| | | Penngift | Emerald | Chemung | 112 | 224 |
| 5 | Tall fescue | 7.82 cd | 5.17 h | 4.54 i | 7.34 d | 9.79 a |
| | Orchardgrass | 7.57 d | 5.10 hi | 4.84 hi | 6.69 e | 8.71 b |
| 10 | Tall fescue | 7.59 d | 5.17 h | 5.88 fg | 6.73 e | 8.69 b |
| | Orchardgrass | 7.63 cd | 5.67 g | 4.97 hi | 6.26 ef | 8.14 bc |

Grass plus Penngift yielded about the same as grass fertilized with 112 kg/ha N, and much more than grass plus either Emerald or Chemung. Tall fescue alone yielded more when cut to 5 rather than 10 cm; stubble height did not affect yields of orchardgrass or the mixtures.

Title: PRODUCTIVITY AND QUALITY OF FERTILIZED PERENNIAL FORAGES

Leader: L. F. Marriott, Pennsylvania

Application of various rates and combinations of N, P, K, and Mg on a 1968 seeding of crownvetch produced no significant yield differences. Low first harvest yields (0.9 tons/acre dry matter) were attributed to weed competition, with the possibility that the 2-cut system in 1970 may have resulted in decreased plant vigor. A 1970 seeding, relatively free of weeds other than Canada thistle, produced 1.8 tons/acre at first harvest and 1.4 tons/acre in October. A portion of the 1968 seeding was given chemical weed control and permitted to grow throughout the season. No yields were taken but growth appeared normal for crownvetch compared with the stunted appearance of the harvested area. The 1970 seeding will be used to determine the effect of harvest schedules on aftermath vigor and stand persistence. The crownvetch stands continued to persist in the grass (bromegrass, orchardgrass, tall fescue) associations with the crownvetch generally contributing less to the total production as N rates increased from 0 to 100 lb/acre.

Applications of Mg to low Mg soils in Cambria County before oats seeding in 1970 had no apparent effect on 1971 stand or growth of legumes seeded in the oats.

Section VII

Plant Pathology

Title: ANTHRACNOSE OF FORAGE LEGUMES

Leader: F. L. Lukezic, Pennsylvania

Investigations of the effects of temperature, CO₂, and metabolic inhibitors on germination and appressorium formation of Colletotrichum trifolii have been completed. Conidial germination was affected by concentration of Tween 20. A high rate of germination and appressorium formation was obtained in 0.083% Tween 20 compared with other concentrations tested.

Appressorium formation was more sensitive to temperature than was germination. The percentage of germinated spores which formed appressoria was reduced at incubation temperatures above 27 C to 35 C. Similarly, germination was reduced with heat exposure, but at longer exposures than those necessary to reduce appressorium formation. Spores in suspension responded to a shorter heat exposure (4 hr) than spores in culture.

A reduced atmospheric CO₂ level did not affect the amount of germination or appressorium formation. However, cell walls of appressoria produced in an atmosphere low in CO₂ were thin walled and without the brown pigment characteristic of normal appressoria.

Protein synthesis inhibitors (cycloheximide and p-fluorophenyl-alanine) blocked both germination and appressorium formation. Nucleic acid synthesis inhibitors were either partially or completely ineffective and their mode of action in C. trifolii is unknown.

Title: ANTHRACNOSE RESISTANCE IN RELATION TO ALFALFA ANATOMY

Leader: R. T. Sherwood, Pasture Research Laboratory

The histology of resistant and susceptible alfalfa clones inoculated with Colletotrichum trifolii was studied. The conidia germinated by forming a short germ tube terminated by a subspherical, brown,

thick-walled appressorium. Resistant and susceptible clones supported similar germination. By the 4th day after inoculation there were small, sunken, brown lesions on the first to fourth stem internodes. In resistant clones these lesions did not expand further. In susceptible plants the lesions girdled and killed succulent stem tissue by the 6th to 10th day.

In resistant plants, the epidermal cell beneath the appressorium died. Often two or more cells on either side and sometimes several cortical cells beneath also died and collapsed. Affected cells contained yellowish brown contents which stained darkly with safranin. The fungus apparently occasionally sent a germ tube into resistant epidermal cells, but this was destroyed by the death of the cell. Thus, the resistance of these clones was characterized by a hypersensitive flecking reaction.

In susceptible plants, a penetration thread grew from the appressorium through the cuticle and outer epidermal cell wall into the epidermal cell where it expanded into a normal hypha. Hyphae elongated, and ramified readily through epidermal and cortical cells. They grew especially abundantly in the phloem and cambium. Hyphae grew within the cells. They were greatly constricted at the point of passage through cell walls. Host nuclei, chloroplasts, mitochondria and cytoplasm degenerated in invaded cells. Sporulating acervuli were formed in the epidermis or within the cortex by 6-10 days.

Hypersensitive flecks sometimes formed on susceptible plants, and frequently formed on a moderately resistant clone. In the latter there were some successful invasions, followed by slowly progressing hyphal colonization.

Title: DISEASE, ALFALFA MANAGEMENT AND THE INCIDENCE AND SEVERITY OF

Leaders: F. L. Lukezic and J. B. Washko, Pennsylvania

Because of the effect of harvesting on susceptibility of alfalfa to root rot and the importance of carbohydrates in root exudates on *Fusaria chlamydospore* germination, investigations were completed on the neutral carbohydrate fraction of root exudates of alfalfa chipped at different levels. Amounts of carbohydrates released per gram dry weight of root tissue were higher under severe chipping, suggesting that increased carbohydrates in exudates may increase the number of germinating chlamydospores.

Resistance to virulent isolates of Cornyeobacterium insidiosum was induced in four susceptible alfalfa cultivars by leaf infiltration with dilute suspension of avirulent mutants from the same original single-celled culture. Challenge tests showed that protection occurred as early as 12 hr and was complete by 24 hr. Challenge tests on companion leaflets indicated that the protection factor(s) is not translocated or light-dependent.

Title: POWDERY MILDEW OF ORCHARDGRASS, LONGTERM CONTROL WITH BENOMYL

Leaders: K. T. Leath and C. C. Berg, Pasture Research Laboratory

Benomyl was applied as a single, soil-drench application for long term control of powdery mildew of orchardgrass in the greenhouse. Dosages of 0.75 mg (active) or less per 450 ml of soil were ineffective. Application of 30 mg protected orchardgrass for approximately 9 months. Protection for 2 years resulted from a drench containing 120 mg of benomyl. Bioassays made 21 months after fungicide application were positive for fungicide activity in the leaves.

Title: RESISTANCE MECHANISMS ASSOCIATED WITH FOLIAR INFECTIONS OF FORAGE CROPS

Leader: R. L. Miller, Cornell

Additional pathogens and nonpathogens of alfalfa were tested for their ability to induce production of and to degrade the alfalfa phytoalexin, medicarpin. All 11 fungi (three pathogens and eight nonpathogens) induced medicarpin production. The three pathogens rapidly degraded medicarpin essentially in the same manner; the nonpathogens either did not degrade medicarpin or degraded it to compounds unlike those determined for the pathogens. Marked differences in sensitivity of the fungi to medicarpin apparently were associated with their relative abilities to degrade the phytoalexin.

Phytoalexin production in birdsfoot trefoil in response to a pathogen, Stemphylium loti and to a nonpathogen was established. Two compounds apparently are produced in response to infection, one with characteristics like those of medicarpin is produced in relatively lower amounts than is the other compound which has not yet been characterized.

The pathogen can rapidly degrade the unidentified phytoalexin. This finding is analogous to the relationship already established for pathogens of alfalfa.

Preliminary studies on phytoalexin production in sweetclover indicate that several phenolic compounds are produced in response to infection; a major component of these compounds closely resembles medicarpin in some but not all of its properties.

Title: VEGETATIVE GROWTH RESPONSES OF ALFALFA PATHOGENS TO SAPONIN AND OTHER EXTRACTS FROM ALFALFA (MEDICAGO SATIVA L)

Leaders: K. T. Leath, Pasture Research Laboratory; K. H. Davis, Jr. and M. E. Wall, Triangle Research Institute, Triangle Park, North Carolina; and C. H. Hanson, USDA, Beltsville, Maryland

Various fractions extracted from 'DuPuits' and 'Lahontan' alfalfas were assayed for biological activity on the vegetative growth of 25 alfalfa pathogens, Rhizobium meliloti Dangeard, and Trichoderma viride Pers. ex Fr. Four saponin mixtures were precipitated from butanol following extraction of the plant material with hexane-heptane, chloroform, chloroform-methanol, and water. DuPuits contained more saponin than did Lahontan. Thin-layer chromatographic analysis delineated six major components in each of the saponin mixtures and indicated that primary differences in the mixtures were quantitative. Growth responses of the test organisms varied with the organism, the fraction, the source variety and the concentration of the fraction. All test concentrations were below those of saponins occurring naturally in alfalfa. In general, the effects of the four saponin mixtures were similar, with those from DuPuits exhibiting more activity than those from Lahontan. The test organisms varied greatly in their responses to all fractions, i.e., unaffected, stimulated or inhibited (fungi-static and fungicidal). The nonsaponin fractions greatly affected the growth of the test organisms, but little effect of source variety was noted. Individual components of saponin mixtures from DuPuits and Lahontan alfalfas are currently being assayed for toxicity to Trichoderma viride.

Title: FORAGE GRASS DISEASE SURVEYS

Leaders: K. E. Zeiders and R. T. Sherwood, Pasture Research
Laboratory

The prevalence and relative severity of foliar diseases in field plots and space plant nurseries were assessed in August and October 1971 at the Rock Springs Agricultural Research Center, University Park, Pennsylvania. A scale of 1-5 was used to score disease severity, where 1 = none or trace and 5 = very severe with some killing of leaves. In replicated field plots, Helminthosporium brown spot was moderate to severe on smooth brome grass in August. 'Achenbach,' 'Fox,' and 'Lincoln' had slightly higher disease scores than 'Blair,' 'Magna,' and 'Sac' cultivars. This disease was less severe in October. Further tests on the reactions of these cultivars are being made in growth chamber inoculations.

Reed canarygrass had little or no leaf disease in either August or October.

Rust was the most important disease on several grass species in October. Mean rust severity scores for orchardgrass were lowest for 'Chinook' and 'Pennlate' (1.5 and 1.8, respectively) and highest for 'Napier' and 'Boone' cultivars (3.5 and 3.3, respectively). Among Kentucky bluegrass cultivars, rust caused by Puccinia poae-nemoralis was very severe on 'Merion' and 'PSU-K124' (4.3 and 4.5, respectively) and only slight on four other cultivars. Rust on 'Norlea' perennial ryegrass was slight to moderate (2.5) while three other ryegrass cultivars had no rust.

Approximately 3000 space-planted orchardgrass plants in a source nursery were scored for rust caused by Puccinia graminis. There was a severe epiphytotic of rust in this nursery. Only 66 plants were scored "1" (0 to trace). Ten to twelve days later only eight plants were still rated "1." Clones selected for resistance and susceptibility are being tested in greenhouse inoculations.

In a space-plant nursery established in 1970 there were differences in severity of Helminthosporium net blotch among Lolium-Festuca hybrid derivative plants. Tiller propagules of selected plants are being tested in the greenhouse.

Section VIII

Utilization and Nutritive Evaluation

Title: REGIONAL PROJECT NE-24--THE NUTRITIVE EVALUATION OF FORAGES

Leader: J. L. Evans, Chairman, Regional Research Committee

Contributors: The Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Vermont, and West Virginia Agricultural Experiment Stations; the U.S. Regional Pasture Research Laboratory and Dairy Cattle Research Branch, ARS, The Cooperative State Research Service, USDA.

The objectives of the NE-24 regional project are (1) to study basic factors controlling the intake and utilization of forage crops by ruminant animals, (2) to cooperate with plant breeders and agronomists in evaluating forage species and varieties by determining intake levels and the digestibility of energy and protein. Among the major factors shown to influence the intake and utilization of forage crops, contributing stations to NE-24 examined the following during 1971, (a) growth stage and maturity (b) species and variety of forage, (c) effects of chemical and physical composition of the diet, and (d) level and type of fertilization.

The NE-24 Regional Project was revised and approved for another four-year period starting July 1, 1971 and ending June 30, 1975. 1971 involved a transition from the previous objectives to the objectives spelled out in the project revision. The objectives for the project revision are to determine basic factors controlling the intake of rations based on forages. Some of the specific factors that are being evaluated by the NE-24 researchers are rumen mechanics, density (physical and chemical), particle size, moisture, soluble and fibrous carbohydrates, minerals, protein and nonprotein nitrogens, physiological state, physiological metabolites, plant composition changes with fertilizer, foliar diseases, and plant germplasm.

Title: DEVELOPMENT AND APPLICATION OF LABORATORY METHODS FOR DETERMINING FORAGE QUALITY

Leader: P. J. Van Soest, Cornell

Further progress was made in 1971 concerning the role of silicon in determining the nutritive value of graminaceous materials. Silica can be completely removed from rice hulls by neutral detergent but not from rice straw or perennial grasses. Increase in digestibility due to the removal of silica was only 20% in case of hulls. Regression slope was 0.62 units of organic matter digestibility per unit of silica removed in rice hulls as opposed to 1.79 in grasses. A method was developed to prepare permanganate cellulose retaining silica in its biological form. Concentration of the silica-organic matter complex was achieved via in vitro rumen digestion. Fractions up to 56% silica have been obtained. These have been subjected to infrared scan (KBr pellet) in search of evidence of silicon-carbohydrate bonds. The reactivity of silicic acid with sugars and tannin has also been investigated.

Other work on the improvement of in vitro rumen methodology has compared the use of paper for filtration in place of crucibles. Results are nearly the same but not identical. In another experiment source of rumen inoculum (forage vs. high grain) was compared in regard to digestibility of a standard set of forages and concentrates. Results are contrary to previous findings of others and indicate only small differences between the ability of inocula to digest forages. However, large differences exist in the case of concentrate cell wall fractions, with the inocula from forage fed animals being superior.

Title: NUTRITIONAL AND PHYSIOLOGICAL ASPECTS OF RUMEN FUNCTION

Leaders: B. R. Baumgardt and T. V. Hersberger, Pennsylvania

The basic two-stage in vitro technique developed for forage evaluation (Tilley and Terry, 1963) was used to evaluate: (1) the feasibility of using a sealed fermentation vessel as opposed to the more conventional vented vessel, (2) the necessity of obtaining inocula from a donor animal on a ration similar to those being evaluated, (3) the merits of a pepsin digestion after fermentation, and (4) the efficacy of using a system to evaluate the digestibility of concentrates (grain rations). Ten forages and 10 concentrates of known digestibility were used as the test substrates. Trials were run on four separate days and the two inocula were used on alternate days. Direct filtering after fermentation, especially with the concentrate samples, was impossible because

the sintered-glass crucibles would clog before the media would pass through. Thus, low and extremely variable dry matter digestibilities (DDM) were obtained if the samples were not subjected to the pepsin digestion. The two-stage in vitro technique accurately estimated the DDM of both forages and concentrates irrespective of the tube type or inoculum source used. The sealed tubes, incubated in an inclined position, tended to digest the forages to a greater extent than the vented tubes which were incubated in a vertical position. It was necessary to calculate separate regression equations for each type of fermentation vessel and feedstuff. Highly significant correlation coefficients of 0.956, 0.967, 0.887 and 0.992 were obtained between the in vivo and in vitro DDM values for sealed vessel, vented vessel, forages and concentrates, respectively.

Title: BIOCHEMISTRY OF FEEDS AND FORAGES AND THEIR NUTRITIVE VALUE

Leader: P. J. Van Soest, Cornell

Laboratory investigation on the biochemistry of feeds continued in several areas in 1971. Samples from feeding-digestion experiments have been analyzed to assay the source of the decline in digestibility often observed with increasing intake. Incomplete results indicate that true digestibility obtained by neutral detergent fractionation of the feces correlated better with intake of digestible energy than did apparent digestibility (-.67 vs. -.53). Decline in digestibility per unit of maintenance was 2.87 units of apparent digestibility and 3.08 units of true digestibility. This result implies that the decline is a result of depression in cell wall digestibility with level of intake. Other investigations have resulted in the development of equations to predict net energy from chemical composition. The efficiency of energy use appears most closely (curvilinearly) related to the proportion of non-cell wall fractions in the feed consumed.

Other problems related to the efficiency of feed use include preliminary measurements of the rate of fermentation in vitro with the intention of relating an integrated model to efficiency and consumption (voluntary intake) of ruminant feeds.

Investigation into the chemical composition of waste papers and their in vitro digestibility has indicated very wide variation in quality (range 21 - 99% digestibility). It does not appear to be a safe generalization to state that all paper is cellulose and that most celluloses elicit similar responses.

Title: STUDIES ON ALLELOCHEMICAL PROPERTIES OF CROWNVELTCH AND THEIR EFFECT ON FORAGE QUALITY

Leader: D. L. Gustine, R. F. Barnes, and G. W. Fissel, Pasture Research Laboratory; J. S. Shenk, Pennsylvania

When crownvelts (Coronilla varia) is incorporated into diets at a level of 45% and fed to weanling meadow voles (Microtus pennsylvanicus) death results in 3 to 5 days. During 6-day feeding-trial periods, the diet intake of the voles is decreased and accompanied by weight loss. Experiments were initiated to isolate and identify the substance present in crownvelts responsible for the facultative toxicity. Crownvelts samples were fractionated by chemical means and bioassayed for activity as follows: (1) a fraction to be tested was incorporated into a diet which contained all necessary nutrients for weanling voles; (2) diets were fed to pairs of voles over a 6-day period; (3) weights of voles and feed were determined at the start and finish of the trial.

Results indicate that the facultative toxic activity is soluble in water, 95% ethanol, and acetone, while it is insoluble in petroleum ether and chloroform. Further purification steps were performed with ethanol extracts as follows: (1) Addition of an equal volume of water produced a green precipitate which was isolated by centrifugation, and then fed to voles. While no activity was detected in the precipitate, it was found in the supernatant fraction. At this stage the activity apparently was not stable under strongly acidic or strongly basic conditions. (2) After removal of ethanol from the supernatant fraction by concentration in vacuo, the resulting aqueous fraction was partitioned against chloroform-ethanol (8.5:1.5). This resulted in a partitioning of the activity into the aqueous layer with a very small amount of activity present in the organic layer.

Further fractionation studies are in progress as well as experiments to chemically characterize the facultative toxicity.

Title: THE NUTRITIVE EVALUATION OF FORAGES (CALORIC DENSITY)

Leaders: B. R. Baumgardt, P. R. Shellenberger, and A. D. Peterson, Pennsylvania

An experiment was initiated to test a previously developed model for predicting feed intake and energy intake from the caloric density ($DE \times D = \text{kcal/ml}$) of the diet. Diets were formulated to contain four levels of DE (2.0, 2.5, 3.0, and 3.5 kcal/g). At each DE level, two

diets were formulated to have different densities and thus different caloric densities (kcal/ml). Thus, eight diets will be used: 2.0 kcal/g (0.8 and 1.2 kcal/ml); 2.5 kcal/g (0.8 and 1.6 kcal/ml); 3.0 kcal/g (1.2 and 2.0 kcal/ml); 3.5 (1.6 and 2.4 kcal/ml).

Sixteen Holstein steer calves 3 months of age at the start will be used.

The above-described experiment will allow us to determine the value of including "density" in addition to DE (kcal/g) for the prediction of intake.

There is considerable practical interest in feeding complete mixed diets to ruminants under ad libitum conditions. Data from our experiments will allow proper formulation of such diets for animals with widely different energy requirements.

Complete mixed diets presently being studied with lactating dairy cows by Dr. L. S. Bull at the University of Maryland will be evaluated with wethers (and lactating ewes) at Penn State. Methods for measuring diet density and inter-species comparisons will be evaluated.

Title: NUTRITIVE EVALUATION OF FORAGES (FORMIC ACID PRESERVATION OF SILAGE)

Leader: J. T. Reid, Cornell

An experiment was carried out to determine the effectiveness of ensiling alfalfa forage with and without formic acid preservation. Formic acid-treated silage had a lower pH and a higher sugar content than untreated silage. Ammonia nitrogen increased at a greater rate and reached a higher level with ensiling time in the untreated silage.

The formic acid silage was consumed in larger quantities by sheep. The digestibility of energy and nitrogen retention by sheep was not different for two silages. Sheep fed the untreated silage lost more urinary energy but less of methane energy than those fed the formic acid silage; thus, the metabolizable energy value was the same for both silages. In respiration calorimetric experiments, the proportions of the metabolizable energy stored as new body tissue were 53.4% for the untreated silage and 54.6% for the formic acid silage. Also, the maintenance requirements for sheep fed the two silages were not different. These data indicate that the main advantage of formic acid treated silage is that animals eat more of it than of untreated silage.

Title: NUTRITIVE EVALUATION OF FORAGES (NITROGEN UTILIZATION)

Leaders: J. L. Evans, M. Garces, Z. Nomani, Z. Lelkes, and
W. Martin, New Jersey

It was reported (J. Anim. Sci. 33: 316. 1971) that the utilization of soluble N was less in equal-N-diets; however, additional soluble N utilized at a lower level provided an improved animal performance with higher-energy corn silage but not with lower-energy alfalfa.

In the first of two voluntary dry matter intake (DMI) trials using high energy diets, N was supplied by corn gluten (diet 1) or urea (diets 2 and 3). Diets 1 and 2 were equal in N, but diet 3 contained additional N from urea. Growing steers consumed the same N source for four consecutive 35-day periods. At the end of each period the dietary percent N was increased in each diet, and period was confounded with percent N. DMI for periods one thru four were 227, 215, 194 and 172 g/W^{0.60}/day. DMI for diets 1 and 2 (2.5% N) were reduced to 177 g in period 4 with diet 3 (3.5 and 4.1% N) reduced to 177 and 160 g in periods 3 and 4. Based on the data from the following trial, it was concluded that reduction in DMI resulted from the increasing diet N from both sources and not period.

In the second DMI trial corn gluten, urea and soybean N were fed at 3 levels each (1.5, 2.3, 3.1% N) using a different experimental design. Increasing levels of corn gluten and urea N decreased DMI:soybean N did not.

Title: UTILIZATION AND NUTRITIVE QUALITY

Leaders: L. S. Bull, J. H. Vandersall, N. A. Clark, A. M. Decker,
and J. A. Schillinger, Maryland

In vitro and in vivo studies on the effects of sulfur (S) source and level on cellulose utilization by rumen bacterial have been continued. Sulfur sources did not affect 48-hour cellulose digestion. Differences between levels within sources were significant up to a level of 0.24% total S (DM basis).

A preliminary study has been conducted to determine the value of composted (aerobic) dairy barn waste as a nutrient source for goats and lactating cows. When fed to cows in place of corn silage, intakes up to 10 kg/day were achieved.

Studies of the effect of protein level in alfalfa on in vitro digestibilities in samples from plots treated with simazine were begun. Results to date show a highly significant reduction in neutral detergent fiber with an increase in protein. There were no changes in acid detergent fiber and digestibility.

Experiments have been conducted to evaluate pelleted whole corn plants as a supplement or substitute for corn silage. Results suggest the pellets are somewhat inferior to corn silage as a source of nutrients. Some heat-damaged protein may be found in pellets which are incorrectly processed.

Sunflowers are being evaluated as a short season row crop silage. Cows consume large quantities of this silage, but the high moisture content limits nutrient intake. Work will continue on the management and utilization of this silage crop.

Title: EFFECT OF STAGE OF MATURITY AND METHOD OF PRESERVATION ON THE NUTRITIVE VALUE OF ALFALFA AND CROWNVETCH

Leaders: T. A. Long, Marvin L. Risius, and L. L. Wilson, Pennsylvania

Alfalfa and crownvetch were harvested in the late-bud and full-bloom stage and preserved as hay and haylage. Each forage was fed free-choice to three lambs in a metabolism trial to determine digestibility and acceptability. The animals were permitted 15 days to voluntarily adjust feed consumption before any measurements were taken.

The following table shows the effects of forage type, method of preservation, and stage of maturity on dry matter digestibility and intake.

Digestible dry matter coefficients (%)

| Species | Haylage | | Hay | |
|------------|----------|------------|----------|------------|
| | Late bud | Full bloom | Late bud | Full bloom |
| Alfalfa | 64.9 | 59.1 | 68.1 | 65.7 |
| Crownvetch | 65.1 | 54.7 | 70.1 | 62.7 |

Dry matter intake (g/day/kg body weight)

| | | | | |
|------------|------|------|------|------|
| Alfalfa | 35.3 | 30.6 | 38.2 | 29.1 |
| Crownvetch | 36.5 | 25.8 | 30.2 | 27.5 |

Title: ROUGHAGE TYPE AND THE NUTRITION AND HEALTH OF RUMINANTS

Leaders: B. R. Baumgardt, T. A. Long and L. Chase, Pennsylvania

It has been postulated that high nonprotein-N levels and/or some unknown N-fraction causes low acceptability of certain forages. To evaluate the effect of nitrogen fertilizer on selected nitrogenous components of alfalfa, a trial was conducted using either 0, 112, or 224 kg of nitrogen/ha. The alfalfa was cut at three maturity stages (prebud, 1/4 bloom, and mature) and five types of forage (fresh, frozen, direct cut silage, low moisture silage, and hay) were prepared from each level of fertilization and stage of maturity.

Samples were analyzed for true protein-N, nonprotein-N, ammonia-N, and nitrate-N in addition to normal proximate analysis. The increasing levels of nitrogen fertilization significantly ($P < .001$) increased the total nitrogen content (3.23, 3.38, 3.53%) of the plant. Nonprotein-N, ammonia-N, and nitrate-N followed a similar pattern. Significant decreases were observed in all nitrogen factors with advancing maturity. Ensiled forages showed a significant increase in the amounts of nonprotein-N and ammonia-N present and significant decreases in true-protein-N and nitrate-N. This study has shown that the chemical composition of forage crops such as alfalfa can be changed through moderate levels of nitrogen. There were significant increases in certain components (nonprotein-N, ammonia-N and nitrate-N) which may have animal health implications, however, no animal experimentation was involved in this study.

Title: SILAGE INVESTIGATIONS

Leader: M. A. Sprague, New Jersey

The object of this study was to determine the effects of temperature during storage and the exclusion of oxygen on the efficiency of retention of feed nutrients.

Much forage (alfalfa as well as perennial grasses) is produced during the fall months too late for hay or silage making. It is currently wasted by remaining in the field throughout the long winter. Further, during warm weather storage of forage as either hay or silage results in considerable loss of feed nutrients. Previous studies indicate most of these losses can be eliminated by anaerobic storage at near freezing temperatures.

Experiments were conducted to determine the influence of storage temperatures (32, 42, and 70 C) and the exclusion of oxygen with additions of dry ice on retention of feed nutrients in alfalfa forage during 5 months storage as silage. Samples obtained before and after storage have been and are being analyzed for available carbohydrates, total nitrogen, and amino acids. The preliminary data indicate major differences in retention of carbohydrates and the presence of certain amino acids, following storage, due to temperature during storage. The data, however, are not yet conclusive. Oxygen analyses continue to show very rapid disappearance in silos; zero percentage is reached in approximately 30 minutes from sealing.

Title: NUTRITIVE VALUE OF SUMMER ANNUALS AND ALFALFA AS GREEN-CHOPPED FORAGE AND SILAGE

Leaders: W. P. Apgar and C. S. Brown, Maine

The intake and digestibility values of two summer annual grasses, i.e., 'Piper' sudangrass and 'Sweet Sioux' sudan-sorghum, have been compared to alfalfa in feeding trials using green-chopped forages fed to dairy heifers and as silages fed to sheep. All trials were replicated over 2 years representing two harvest seasons.

Although there were differences between years in the case of the green-chopped forages, the relationship among the forage digestibility values did not change appreciably. In both years Sweet Sioux had the highest average dry matter digestibility (61.5% and 80.4%), with Piper next in order (57.8% and 78.2%) followed by alfalfa (56.1% and 70.9%). Intake of DM was very similar among the first year's forages. However, during the second year intake of both annual grasses was significantly higher than that of the alfalfa. Within respective years, the average Dm intake by heifers expressed as percentage of body weight was: Sweet Sioux (1.6 and 2.3%), Piper (1.7 and 2.5%) and alfalfa (54.9 and 56.6%). Average intake of DM expressed as percentage of body weight was the same among the silages during the first year (1.8%). However, during the second year average DM intake varied among the silages (Sweet Sioux 2.0%, Piper 1.6% and alfalfa 2.0%).

In the overall evaluation of intake and digestibility, the summer annuals compared favorably with the alfalfa when fed to ruminants as green-chopped forage and silage.

Title: THE NUTRITIVE EVALUATION OF FORAGES

Leaders: J. B. Holter, J. R. Mitchell, H. A. Davis, and W. E. Urban, Jr. , New Hampshire

During the year lactating cows were fed concentrate adjusted to the level of production, corn silage (40% DM with 0.5% urea) as 60% of forage DM, and either hay (harvested June 15) or haylage (40% DM, harvested June 3 from same crop as hay) as 40% of forage DM. In addition to collecting data on complete lactation production, breeding efficiency and health, four cows from each ration treatment groups were subjected, during the 6th and 21st weeks of lactation to complete energy and nitrogen balance and digestibility trials. Concurrently a 4 x 4 Latin square trial was carried out using four dry cows fed concentrate, corn silage, hay and haylage separately at two levels of intake to determine energy and nitrogen partition and nutrient digestibility for each ration component. Nutritive value of ration components and total mixed rations will be compared. Data currently are being summarized.

Title: MAXIMUM EFFICIENCY OF FORAGE UTILIZATION BY BEEF CATTLE

Leader: J. I. Miller, Cornell

Two lots of mature dry beef cows were wintered on the following average daily rations; Lot I, fed 22 lb of low quality mixed hay once daily; and Lot II, fed 10 lb good quality mixed hay plus 40 lb good quality corn silage divided into two feedings daily. At the end of the feeding period and prior to calving, Lot I cows were obviously in thinner condition than the cows in Lot II fed on the higher plane of nutrition. However, for the cows calving prior to the pasture season (43 cows) there were no significant differences between lots in birth weights of calves, calving difficulty, or mothering ability. There was a high correlation between weight of dam and condition score.

One lot of yearling heifers averaging 800 lb at the start was wintered on mixed hay and corn silage in comparison with a similar, but somewhat younger, group of heifers which received 7 lb of a mixed concentrate in addition to the same amount of mixed hay but less corn silage. Each feeding system was considered satisfactory although the grain-fed heifers gained more and were fleshier at the end of the trial.

Each trial indicated that the more costly, higher energy rations were not essential for satisfactory performance by either the brood cows or the breeding heifers.

Title: THE EFFECTS OF CULTIVARS AND PRODUCTION METHODS ON THE
FEEDING VALUE OF CORN SILAGE

Leader: N. A. Clark, Maryland

Two selections of high lysine corn were compared for feeding value of the stover silage. The corn selections were grown in split plots with the whole plots being fertilizer treatments of N, Mg, Ca, and K in a factorial arrangement. A severe hailstorm on August 15 damaged the corn so badly that yield differences could not be obtained. Only the stover is being considered for silage as the grain would have greater value for swine or poultry. Stover samples have been obtained for chemical analyses, but these analyses have not yet been made.

Title: ENSILED BLIGHTED CORN SAFE FOR ANIMAL FEEDING

Leaders: T. A. Long, Herbert Cole, and B. R. Baumgardt, Pennsylvania

Silage from severely leaf-blighted corn fed to lambs in a 42-day experiment caused no serious problems of acceptability or toxicosis that could be attributed to the blighted corn.

The fresh chopped corn contained viable sources of fungus, more than would be found on normal healthy corn plants. Penicillium, Fusarium and Aspergillus species were present, all of which have been implicated in mold toxicosis problems. Ten weeks after ensiling, the corn was almost completely free of detectable fungus.

Title: EFFECT OF CORN GREEN CHOP ON DIGESTION PATTERN IN THE
RUMEN OF THE BOVINE

Leaders: H. Fenner and W. G. Colby, Massachusetts

Uniform rations of corn green chop fed, intake controlled, as the sole diet to four rumen fistulated cows showed considerably different fermentation patterns than similar rations previously fed to the same cows as corn silage. Corn green chop produced substantially higher pH values and lower concentrations of total volatile bases and VFA's in the rumen. Observed changes of these constituents, as affected

by time of sampling after feeding, allow us to conclude that digestion rates in the rumen of green chop fed cows were low and retarded by lack of or slow availability of the corn protein in this form for microbial cell synthesis. Also, significantly higher proportions of iso- and n-butyric acids and slight higher proportions of acetic and propionic acids of the total acids were observed in rumen fluids from the green chop fed cows.

Also proportions of iso- and n-valeric and n-caproic acids were lower than those observed with the corn silage rations. In this respect corn green chop produces fermentation patterns similar to those of green grass and hay.

This also is true for changes of the n-butyric acid proportion as affected by time of sampling after feeding. Corn silage and other well cured forage silages cause decreases in n-butyric acid proportions of the total acids during the first 2 to 3 hours after feeding, while the reversed pattern occurs in green corn, grass and hay fed cows. Other products than acids of silage fermentation origin are assumed to be responsible for these changes.

Title: DOUBLE CROPPING BARLEY AND CORN FOR FORAGE USING NO-TILLAGE
 CORN PLANTING

Leader: L. Hofmann, Maryland

Corn silage yields were obtained in 1970 from crops planted by no-tillage and conventional methods at planting dates which simulated one-crop corn silage; double cropping barley for silage followed with corn for silage; and barley for grain followed with corn for silage.

| Date of planting | Tons 35% dry matter corn silage | | |
|---------------------------|---------------------------------|------------|---------|
| | Conventional | No-tillage | Average |
| May 13 (one crop) | 21.9 a * | 17.3 b | 19.6 |
| May 22 (grain silage) | 18.6 b | 14.2 c | 16.4 |
| June 29 (grain for grain) | 11.1 d | 10.6 d | 10.9 |
| Average | 17.2 | 14.0 | |

* Numbers followed by the same letter are not significantly different at the 5% level of probability according to Duncan's Multiple Range Test.

After the final corn silage harvest, plots were seeded to winter rye (one crop system), Wong barley (grain silage plus corn silage), and 'Barsoy' barley (grain for grain plus corn silage). The small grain grown on previous no-tillage corn plots visually showed signs of fertilizer deficiency, which was reflected in the 1971 yields. Barley grown on conventional plots produced 7.98 tons/acre silage, whereas, that from no-tillage plots produced 4.79 tons/acre. Barley grain yields averaged 74.9 bu/acre and 56.8 bu/acre for conventional and no-tillage plots, respectively.

The study is being continued to determine long-term effects of the double cropping program on forage yielding potential and potential use as a forage program in Maryland.

Title: INFLUENCE OF DATE OF PLANTING ON YIELD AND MATURITY OF CORN GROWN FOR SILAGE

Leader: V. H. Holyoke, Maine

A study was initiated to consider the influence of 4 planting dates on the yield and maturity of two corn hybrids. Plantings were made at 10-day intervals beginning on May 10.

The hybrids consisted of one short season variety requiring about 1500 heat units for maturity and one full season hybrid requiring about 1850. The experiment was laid out in a randomized complete block with 4 replications.

The preliminary results indicate that at the earliest planting date the full season hybrid produces higher yields, but at the three later planting dates there is no yield difference.

Title: EVALUATION OF PASTURES FOR DAIRY HEIFERS

Leaders: E. M. Kesler and J. B. Washko, Pennsylvania

This project was initiated in spring 1971 and is designed to extend over at least three grazing seasons. Seedings of orchardgrass-alfalfa or orchardgrass alone were established. The orchardgrass will receive nitrogen applications during grazing. The plots will be grazed rotationally by yearling dairy heifers. In another phase of the experiment yearling heifers were grazed on similar areas of existing

permanent pasture. Treatments were: (1) pasture alone; (2) forty five percent of the area grazed in early season, hay harvested from the remainder, and the entire area grazed in mid- and late-season; (3) entire area grazed and heifers were offered a supplemental feed of ground waste paper plus molasses and animal fat. All pastures were clipped as needed during the season. Growth performance by the animals was poorest on Treatment 3.

Title: VALUE OF PASTURES FOR CROSS-BRED DAIRY-BEEF COW AND CALF HERDS

Leaders: J. B. Washko and L. L. Wilson, Pennsylvania

Orchardgrass pasture swards fertilized with 100 lb/acre of nitrogen, 50 in the early spring and 50 in midsummer, produced highest dry matter yields, 2.96 tons/acre when grazed rotationally with Holstein-Angus crossbred cattle and their calves. Birdsfoot trefoil with late maturity strains of orchardgrass and reed canarygrass was the next most productive, 2.90 tons/acre. Kentucky bluegrass was least productive, 1.98 tons/acre. The orchardgrass swards provided 110 days of grazing for a cow and her calf for the season; the birdsfoot trefoil-grass combination, 103 grazing days; and the Kentucky bluegrass, 75 grazing days/acre.

Title: EFFECTIVE USE OF BLUEGRASS-WHITE CLOVER HILL PASTURES

Leaders: G. C. Anderson and L. P. Stevens, West Virginia

Hill grazing lands represent an important protein producing resource in the Appalachian Region capable of significant contributions to economy and conservation. These grazing lands vary greatly in their ecology and an understanding of this is essential for the development of supporting management systems.

Previous trials have established existence of marked differences between hill pastures with a southern or a northern exposure (elevation 1800 ft). Higher temperatures on the southern exposure permit grazing to begin at least 2 weeks earlier than on the northern exposure. Current trials are designed to examine effects of level of use, i.e., stocking rate, and expanding the grazing period through fall and early spring grazing of fescue areas associated with the hill pastures.

In situ stored forage on the fescue meadows was used to soften the impact of climate on length of grazing period as follows: 19 days of fall grazing (950 steer days) and 14 days (252 s.d.) and 26 days (468 s.d.) of spring grazing for steers in the southern and northern exposure systems, respectively. This represents an increase of about 15% in the grazing period. Yield of harvested forage from the fescue areas was reduced to about the same extent but did not jeopardize necessary food stores.

Level of utilization was examined by including three ewes and four lambs with three steers on six of the twelve units. Earlier work suggested that this level of stocking should result in a close to maximum utilization and protein production. Performance as reflected by bodyweight gain/acre are as follows: northern exposure systems -- cattle alone 168 lb, sheep and cattle 150 lb; southern exposure systems -- cattle alone 187 lb, sheep and cattle 209 lb. Botanical composition is being measured and results suggest that marked changes will become increasingly apparent with succeeding seasons.

Study of interaction between dry matter availability and components of grazing behavior was continued.

Title: SELECTION AND MANAGEMENT OF FORAGE SPECIES FOR HORSES

Leaders: T. L. Merritt, J. B. Washko, and T. V. Hershberger,
 Pennsylvania

The nutritive content of pasturage grazed by horses was high with protein content ranging from 19.2 to 22.3% and TDN from 65.1 to 70.3% on a dry weight basis. Kentucky bluegrass-smooth brome-grass-timothy with alfalfa produced the most feed nutrients/acre, 1357 lb of protein and 4663 lb of TDN. When the grasses listed above were grown alone and fertilized with 200 lb/acre of nitrogen, they produced 1199 lb of protein/acre. Only 928 lb of protein/acre was produced when 100 lb of nitrogen was applied and 1013 lb of protein when birdsfoot trefoil substituted for alfalfa in the mixture. These results indicate that the most productive pasturage for horses can be grown by the use of 200 lb of nitrogen/season on grasses applied in 50-lb split applications or by growing grasses with a vigorous legume like alfalfa.

Mature horses grazed the plots in 1971 and maintained their condition at an acceptable level during the grazing periods. Considerable spot grazing was observed in all plots with the most noticeable evidence in the plots that contained a mixture of grasses and either alfalfa or birdsfoot trefoil. Horses have consistently shown a preference for grasses; however, serious spot grazing has also occurred in plots containing pure stands of grasses.

Section IX

Weed Investigations

Title: CONTROL OF WEEDS IN PASTURES AND FORAGE CROPS

Leaders: C. Veatch, G. C. Anderson and J. A. Balasko, West Virginia

A series of trials using 4-amino-3,5,6-trichloropicolinic acid was conducted to determine the effectiveness of this compound for the control of iron weed (Vernonia altissima). Applications of the herbicide as a dry material or as a spray produced very encouraging results, efficacy being nearly 100% without any observable undesirable effects. It is important, however, to record the following: (1) no legumes were present prior to treatment so the effect on clovers, etc., which is known to be deleterious could not be assessed, and, (2) the principal grass species was fescue (K31). Growth of this grass on the treated areas was considered to be more prostrate than is considered to be normal and its appearance resembled that which would be expected from the response to an application of about 30 lb of nitrogen/acre. Additional trials have been undertaken.

This herbicide in dry form (Dow Tordon 10K) was combined with 0-46-0 pelleted fertilizer (300 lb/acre) and applied to hill pastures via helicopter in an extension of earlier studies on the control of woody plants. Levels of Tordon 10K reflecting 0.5, 1.0, and 2.0 lb of active material/acre were applied. Adjacent areas were similarly fertilized but the herbicide was applied by hand with the objective of determining the relative efficacy of aerial and hand application when woody plants are dispersed or intermittent in concentration.

Title: WEED CONTROL IN PASTURES AND FORAGE CROPS WITH A MINIMUM OF CHEMICAL RESIDUES

Leader: D. L. Linscott, USDA, PSR, CPRB, and Cornell University

Studies on the mechanism of production of 3-(2,4-DP) in grass from topically applied 2,4-D indicated that the compound is formed through the involvement of 2,4-D in fatty acid synthesis and degradation mechanisms. Modification of the 2,4-D molecule by 3-(2,4-DP) formation

inactivates it biologically and may explain in part the resistance of grass to 2,4-D. Other detoxification processes found in 2,4-D resistant grass include: 2,4-D diglyceride formation in timothy, orthochlorophenoxyacetic diglycerides in orchardgrass, para-dechlorination of 2,4-D in bromegrass, cleavage of 2,4-D and probably 3-(2,4-DP) at the ether linkage. This cleavage resulted in incorporation of the aliphatic moiety into fatty acids.

Mixed solutions of dalapon-dinoseb or dalapon-2,4-DB damaged alfalfa more severely than split-spray applications. Surface tension of the mixtures was lowered resulting in decreased droplet-leaf contact angle and increased spreading over the leaf surfaces. A dalapon-dinoseb mixture assumed the spreading character of dalapon and the drying-absorption character of dinoseb. Retention of applied spray was considerably greater with the mixture of compounds than with dinoseb alone. The pH of dalapon, dinoseb and dalapon-dinoseb mixtures was 4.1, 7.1, and 7.0 respectively; thus, dalapon-dinoseb assumed the pH character of dinoseb. Accentuated foliar damage by the mixtures was attributed to increased total absorption of dinoseb.

Crownvetch (Coronilla varia) establishment was outstanding for the third consecutive year as the result of controlling weeds with incorporated applications of EPTC or benefin followed by between row applications of simazine or bromacil at planting. Seed yields from best treatments averaged 270 kg/ha in 1970 and 180 kg/ha in 1971.

Title: ANNUAL WEED CONTROL IN NEW SEEDINGS OF ALFALFA

Leaders: W. M. Dest, R. A. Peters, and A. C. Triolo, Connecticut (Storrs)

Several herbicides alone and in combination were applied on a new spring seeding of alfalfa at the Agronomy Research Farm, University of Connecticut. The principal weeds were large crabgrass (Digitaria sanguinalis L.), redroot pigweed (Amaranthus retroflexus L.) and common lambsquarters (Chenopodium album L.).

The most effective single herbicide was S-6044 at 4 lb/acre giving both grass and broadleaf weed control without injury to the alfalfa. The 2 lb/acre rate gave good control of broadleaf weeds but only fair control of crabgrass. An herbicide quite active on broadleaf weeds was needed with EPTC to give broad spectrum weed control. 2,4-DB, or bromoxynil, at 1/4 and 3/8 lb/acre gave good yields of alfalfa. Bromoxynil, 1/2 lb/acre, and dinoseb gave good weed control but caused some injury to alfalfa. When bromoxynil was used alone, grasses proliferated. The combined effect of initial alfalfa injury and heavy

grass competition resulted in complete suppression of alfalfa. By harvest time, VCS 438 caused alfalfa injury and very poor grass control. BAY 94337 caused severe injury to alfalfa and poor grass control.

Title: MIDLAND FORAGE YIELDS AND WEED CONTROL AS INFLUENCED BY SOD SEEDING, CONTROLLED FLAMING, AND NITROGEN FERTILIZATION

Leaders: A. M. Decker and W. L. Harris, Maryland

Midland bermudagrass plots were treated for the second year (1970 Annual Report, p. 54) with only one modification. The early flaming was delayed from early March until April 15, 11 days ahead of the late flaming.

Results were generally similar to those obtained in 1970, but there were some notable exceptions. Highest total forage yields and best control of winter annual weeds were obtained with the sod-seeding treatment. Late flaming was next best, followed by early flaming and then the check treatments. Early flaming did not markedly change total weed-free forage yields but it did significantly lower total weed growth. There was a carryover in weed control. Plots that were flamed in 1970 had fewer weeds in 1971. There were yield increases with each increment of nitrogen up to 800 lb N/acre. In contrast to 1970 results, there was a slight advantage of NH_4NO_3 over urea nitrogen.

Title: HERBICIDE COMBINATIONS AND ADJUVANTS FOR RYE KILL IN NO-TILLAGE CORN

Leader: R. A. Peters, Connecticut (Storrs)

Rye kill with paraquat was obtained with 0.5 lb/acre of paraquat but not with the 0.25 lb/acre rate unless 3 oz/acre X-77 or Charger E adjuvants were added. Booster plus E oil at 1 qt in 40 gal of solution enhanced kill but was less effective than the former adjuvants. Inclusion of liquid nitrogen in the spray solution significantly reduced paraquat activity. Atrazine + Booster plus E (2+1 qt/acre) gave very poor rye kill. Atrazine 1 lb/acre, alachlor 2 lb/acre or a combination of the two, enhanced the activity of paraquat but not as much as the adjuvants. Very little control of rye was obtained when using only atrazine, alachlor, or a combination of the two.

Control of emerged (1-2 leaf stage) crabgrass by paraquat with or without X-77 or Charger plus E was only fair to poor. Atrazine with Booster plus E gave the best control (rating of 3) at the stage of growth applied. An increase in activity was obtained by adding 1 lb/acre of atrazine to the paraquat treatments but the kill was not satisfactory. Alachlor at 2 lb/acre combined with the paraquat treatments gave much better control.

Title: EFFECT OF METHOD OF APPLICATION ON ANNUAL GRASS AND BROADLEAF WEED CONTROL IN CORN

Leaders: R. A. Peters and W. M. Dest, Connecticut (Storrs)

Excellent control of crabgrass (Digitaria sanguinalis), lambsquarters (Chenopodium album) and redroot pigweed (Amaranthus retroflexus) was obtained from EPTC at 3 lb/acre without injury to field corn when grown in a fine sandy loam at Storrs. There was serious injury at 6 lb/acre which was reduced but not eliminated with a 1/8 or 1/2% seed treatment of an antidote, R-25788. Sutan 3 lb/acre gave only fair grass control and very poor broadleaf weed control as compared to EPTC.

Atrazine 1 lb/acre + alachlor 1-1/2 lb/acre was more effective when lightly incorporated with a rotary hoe than when disked in or applied preemergence. There was only 0.2 inches of rainfall within the first 3 weeks after application, thus light incorporation enhanced weed control. If atrazine 1 lb/acre + alachlor 3 lb/acre was used a pre-emergence treatment was satisfactory.

In contrast atrazine 1 lb/acre plus sutan 3 lb/acre was more effective with a disk rather than rotary hoe incorporation on both crabgrass and the broadleaf weeds.

S-6115 (cypramid) 1-1/2 lb/acre was more effective for crabgrass control when disk incorporated than when applied preemergence. Broadleaf weed control was poor with either method of application.

Title: FACTORS INFLUENCING GERMINATION OF FALL PANICUM (PANICUM
DICHOTOMIFLORUM MICHX.) AND WITCHGRASS (PANICUM CAPILLARE L.)

Leaders: R. A. Peters and Carlos Rivera, Connecticut (Storrs)

Both panicum species displayed dormancy at the time of harvest. Germination of both species increased with age but only if exposed to light. A 0.2% KNO_3 substrate enhanced germination of both species. With 3-month-old seed there was an 86% increase in fall panicum and a 95% increase in witchgrass. Variable temperatures were necessary for germination with a 27 - 30 C cycle much more effective than 21 - 27 C. The need for higher temperatures, however, was much less evident when seeds were germinated on a KNO_3 substrate.

Optimum time for scarification of panicum seed decreased with age of seed. Fall panicum seed responded to a greater degree than witchgrass seed.

Dormancy in fall panicum and witchgrass seed was associated with the seed coat. Lack of water penetration was ruled out since both dormant and nondormant seeds absorbed the same amount of water when soaked for 48 hours.

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Recipients of Graduate Degrees -- 1971

| Name | Institution | Advisor | Thesis Title |
|--------------------|---------------------|-----------------|--|
| <u>M.S. Degree</u> | | | |
| Crissman, G. J. | West Va. Univ. | D. J. Horvath | The effectiveness of dolomite limestone compared to calcic limestone as a liming agent to several soils in the prevention of hypomagnesemia. |
| Ferguson, J. E. | Cornell Univ. | R. P. Murphy | Some studies of the morphology of a multi-foliolate population of alfalfa (<u>Medicago sativa</u> L.) |
| Hollaway, W. T. | Univ. Maryland | W. E. Bickley | The establishment of <u>Microctonus aethiops</u> (Nees), a braconid parasite of the alfalfa weevil, <u>Hypera postica</u> (Gyllenhal) in Maryland. |
| Kategile, J. A. | West Va. Univ. | R. L. Reid | The effects of nitrogen potassium and zinc fertilization and growth stage on the nutritional quality of orchardgrass. |
| Kennett, Walter. | Univ. New Hampshire | J. B. Holter | Productive responses of Holstein cows fed corn silage and three levels of hay. |
| Keske, Loren G. | Penn. State Univ. | B. R. Baumgardt | Evaluation of <u>in vitro</u> digestion procedures for forages and grain rations. |
| Kimble, John M. | Univ. Vermont | R. J. Bartlett | Fate of nitrogen in a clay soil treated with manure and/or nitrogen for continuous corn. |
| Mathias, E. L. | West Va. Univ. | G. A. Jung | Response of three perennial grass species to some growth-regulating chemicals. |

Recipients of Graduate Degrees -- 1971 (continued)

| <u>Name</u> | <u>Institution</u> | <u>Advisor</u> | <u>Thesis Title</u> |
|----------------------------|--------------------|----------------|---|
| <u>M.S. Degree (cont.)</u> | | | |
| McBryde, Richard W. | Univ. Maryland | N. A. Clark | An evaluation of five sorghum and three soybean varieties for use in a silage mixture. |
| Miehle, B. R. | Penn. State Univ. | F. L. Lukezic | Studies on conidial germination and appressorium formation by <u>Colletotrichum trifolii</u> Bain and Essary. |
| Pruss, L. J. | Penn. State Univ. | E. M. Kesler | Palatability and digestibility of summer annuals when fed as silage to lactating dairy cows. |
| Ranney, T. A. | Univ. Vermont | J. L. McIntosh | Effects of applied nitrogen and manure on movement and availability of nutrients. |
| Rivera, C. M. | Univ. Connecticut | R. A. Peters | Germination, growth, and development of fall panicum and witchgrass. |
| <u>Ph.D. Degree</u> | | | |
| Bennett, O. L. | West Va. Univ. | G. A. Jung | Effect of slope inclination and orientation on yield and water use of forage species. |
| Brann, D. E. | West Va. Univ. | G. A. Jung | Forage evaluation of crownvetch, <u>Coronilla varia</u> L., under different environmental conditions and cutting managements. |

Recipients of Graduate Degrees -- 1971 (continued)

| Name | Institution | Advisor | Thesis Title |
|-----------------------------|-------------------|-------------------------------|--|
| <u>Ph.D. Degree (cont.)</u> | | | |
| Carroll, R. B. | Penn. State Univ. | F. L. Lukezic | Studies on <u>Corynebacterium insidiosum</u> and bacterial wilt of alfalfa. |
| Ferrer, F. R. | Penn. State Univ. | A. A. Hower, Jr. | Effects of gamma radiation on the reproduction of the alfalfa weevil, <u>Hypera postica</u> (Gyll.) |
| Fusco, R. A. | Penn. State Univ. | A. A. Hower, Jr. | A laboratory study of the productivity of the alfalfa weevil parasite, <u>Microctonus aethiops</u> Nees, in relation to various environmental, host, and parasite factors. |
| Hamlen, R. A. | Penn. State Univ. | F. L. Lukezic and J. R. Bloom | Identification of carbohydrates in root exudates of alfalfa, <u>Medicago sativa</u> L. cv. Du Puits, grown under gnotobiotic conditions, and their influence on egg hatch of <u>Meloidogyne incognita</u> (Kofoed and White) Chitwood. |
| Karue, C. N. | Rutgers Univ. | J. L. Evans | Metabolism of nitrogen, voluntary intake, nutrient requirements and digestibility by the East African zebu--the Boran. |
| Mislevy, P. | Penn. State Univ. | J. B. Washko | Morphological and physiological response of Climax timothy (<u>Phleum pratense</u> L.) and Penn-late orchardgrass (<u>Dactylis glomerata</u> L.) under different harvest management systems. |
| Schneider, B. A. | Univ. Maryland | N. A. Clark | Influence of soil fertilization on the nutritive value of corn and alfalfa. |

